Appendix A: Draft Environmental Assessment

Mingo, Pilot Knob and Ozark Cavefish

National Wildlife Refuges

Draft Environmental Assessment

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DRAFT ENVIRONMENTAL ASSESSMENT FOR IMPLEMENTATION OF COMPREHENSIVE CONSERVATION PLAN FOR MINGO, PILOT KNOB AND OZARK CAVEFISH NATIONAL WILDLIFE REFUGES

Abstract: The U.S. Fish and Wildlife Service is proposing to implement a Comprehensive Conservation Plan (CCP) for Mingo National Wildlife Refuge (NWR), as well as for Pilot Knob and Ozark Cavefish National Wildlife Refuges, which are managed by Mingo NWR staff from that refuge. All three refuges are located in Missouri. This Draft Environmental Assessment (EA) considers the biological, environmental and socioeconomic effects that implementing the CCP (the preferred alternative is the proposed action) and three other alternatives for Mingo NWR (and one alternative each for Pilot Knob and Ozark Cavefish NWR's) would have on the issues and concerns identified during the planning process. The purpose of the proposed action is to establish the management direction for the three refuges for the next 15 years. The management action will be achieved by implementing a detailed set of goals, objectives, and strategies described in a CCP.

Responsible Agency and Official:

Robyn Thorson, Regional Director

U.S. Fish & Wildlife Service
Bishop Henry Whipple Building
1 Federal Drive
Ft. Snelling, MN 55111

Contacts for additional information about this project:

Kathleen Burchett, Refuge Manager

Mingo National Wildlife Refuge
24279 State Highway 51
Puxico, MO 63960
Office Phone: (573) 222-3589
Fax: (573) 222-6343

Dean Granholm

U.S. Fish & Wildlife Service
NWRS/Conservation Planning
Bishop Henry Whipple Building
1 Federal Drive
Ft. Snelling, MN 55111

Chapter 1: Purpose and Need

1.1 Background

This EA accompanies the CCP for three national wildlife refuges located in Missouri: Mingo, Pilot Knob and Ozark Cavefish. All three refuges have one CCP because each refuge is managed by Mingo NWR staff based at Mingo NWR; neither Pilot Knob NWR nor Ozark Cavefish NWR has its own staff or facilities.

1.1.1 Mingo National Wildlife Refuge

Mingo National Wildlife Refuge was established in 1944 under authority of the Migratory Bird Treaty Act. The 21,592-acre Refuge is situated in Stoddard and Wayne Counties in southeast Missouri, approximately 150 miles south of St. Louis. The Refuge provides habitat for resting and wintering area for migratory waterfowl, and peak populations of 125,000 mallards and 75,000 Canada geese have been recorded. The Refuge contains approximately 15,000 acres of bottomland hardwood forest, 5,000 acres of marsh and water, 1,275 acres of cropland and moist soil units, and 700 acres of grasslands.

Recreational activities on the Refuge include fishing, hunting of waterfowl, squirrel, turkey, and deer, canoeing, and wildlife observation. Annual visitation to the Refuge has averaged about 97,000 visits over the past 5 years. Public facilities include a Visitor Center, a cooperative association sales outlet, a 1-mile self-guided boardwalk trail, a 19-mile self-guided Auto Tour Route, five overlooks, picnic tables, and a picnic shelter. A 7,730-acre portion of the Refuge is designated by Congress as Wilderness protected under the 1964 Wilderness Act.

1.1.2 Pilot Knob National Wildlife Refuge

Pilot Knob National Wildlife Refuge was established in 1987. The 90-acre Refuge, a donation of the Pilot Knob Ore Company, is located on Pilot Knob Mountain in Iron County, Missouri. The Refuge contains abandoned iron mine shafts excavated in the mid-1800s that have since become critical habitat for the federally endangered Indiana bat. Bats enter the shafts in the fall to hibernate and exit in the spring. Up to a third of the known world population of Indiana bats are believed to hibernate in the old mine. In order to avoid disturbance to the sensitive bats, the Refuge is closed to public use. The Refuge is managed by Mingo National Wildlife Refuge staff located approximately 75 miles away at Mingo NWR.

1.1.3 Ozark Cavefish National Wildlife Refuge

Ozark Cavefish National Wildlife Refuge was established in 1991 to protect the federally endangered Ozark cavefish. The 41.8-acre Refuge is located in Lawrence and Newton Counties, Missouri, twenty miles west of Springfield. Turnback Creek Cave Spring is located on the Refuge. The spring is the outlet of an underground stream that contains a population of the Ozark cavefish. Human access to the underground stream is through Turnback Cave, which has openings on adjacent Missouri Department of Conservation land. The Refuge is closed to public use. Ozark Cavefish NWR is also managed by Mingo National Wildlife Refuge staff.

1.2 Purpose

The purpose of the proposed action is to specify management directions for Mingo National Wildlife Refuge, Pilot Knob National Wildlife Refuge, and Ozark Cavefish National Wildlife Refuge for the next 15 years. These management directions will be described in detail through three distinct sets of goals, objectives, and strategies (one for each refuge) in a Comprehensive Conservation Plan (CCP).

The action is needed because adequate, long-term management direction does not currently exist for the refuges. Management is now guided by various general policies and short-term plans. The action is also needed to address current management issues and to satisfy the legislative mandates of the National Wildlife Refuge System Improvement Act of 1997, which requires the preparation of a CCP for all national wildlife refuges in the United States.

An additional purpose of the EA is to provide direction and consideration of the Mingo NWR's fire management program, which is integral to the CCP.

1.3 Need for Action

The CCP ultimately derived from this EA will establish the overall management directions for Mingo, Pilot Knob, and Ozark Cavefish national wildlife refuges over the next 15 years. All three ref-

uges currently lack long-term management plans. Instead, management is broadly guided at present by general Service policies, by interpreting the official purposes for which each refuge was created, and by short-term, step-down management plans.

This EA will present four management alternatives for the future of Mingo NWR, and two alternatives each for Pilot Knob and Ozark Cavefish. For each refuge, the preferred alternative will be selected based on its ability to meet identified goals. These goals may also be considered as the primary need for action. Goals for the refuges were developed by the planning team and encompass all aspects of refuge management, including wildlife management, habitat management, and public use. Each of the management alternatives for the three refuges described in this EA will be able to at least minimally achieve these goals.

1.3.1 Mingo National Wildlife Refuge Goals

1. The Refuge will actively conserve a mosaic of upland and wetland habitats, including designated wilderness, through appropriate management strategies that preserve, protect, and enhance the vitality and health of the natural environment.
2. The Refuge will provide for a diversity of migratory birds and native fish and wildlife associated with healthy Refuge habitats and contributing to the mission of the National Wildlife Refuge System.
3. Provide a variety of wildlife dependent recreational and educational opportunities to allow the public to enjoy the resources of the Refuge and support the National Wildlife Refuge System.
4. Protect natural, cultural, and man-made resources and provide for the safety of staff, volunteers, and visitors to the extent feasible.
5. Preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries.
6. Seek opportunities to obtain sufficient human resources and facilities through partner and agency funding mechanisms to achieve the goals and objectives of the CCP.

1.3.2 Pilot Knob National Wildlife Refuge Goals

1. Contribute to the recovery of federally listed species and the conservation of their subterranean habitat on the Refuge.
2. Local residents and visitors are aware of the Refuge and its purpose.

1.3.3 Ozark Cavefish National Wildlife Refuge Goals

1. Contribute to the recovery of federally listed species and the conservation of other subterranean species and their habitats within the Springfield Plateau.
2. Landowners in the recharge area of Turnback Cave apply best management practices to maintain water quality.

1.4 Decision Framework

The Regional Director for the Midwest Region (Region 3 of the U.S Fish and Wildlife Service) will need to make two decisions based on this EA: (1) select an alternative for each refuge, and (2) determine if the selected alternative is a major Federal action significantly affecting the quality of the human environment, thus requiring preparation of an Environmental Impact Statement (EIS). For Mingo NWR, the planning team has recommended Alternative 4 ("Balanced Expanded Public Use and Habitat Management" Alternative) to the Regional Director. In the case of each Pilot Knob NWR and Ozark Cavefish NWR, the team recommends Alternative 2 ("Expand Species Protection and Opportunities for the Public") to the Regional Director. The Draft CCP was developed for implementation based on these recommendations.

1.5 Authority, Legal Compliance, and Compatibility

The National Wildlife Refuge System includes federal lands managed primarily to provide habitat for a diversity of fish, wildlife and plant species. National wildlife refuges are established under many different authorities and funding sources for a variety of purposes. The purposes for Mingo NWR were derived from several federal statutes, including the Migratory Bird Conservation Act, Refuge Recreation Act, and Wilderness Act. Both Pilot Knob and Ozark Cavefish NWR's were authorized and given their purposes by the Endangered Species Act of 1973. The appendices of the Draft CCP contain a list of the key laws, orders and regulations that provide a framework for the proposed action.

1.6 Scoping of the Issues

The refuges' CCP planning process began in September 2003 with a kickoff meeting and preliminary site visit at Mingo NWR that included staff from Mingo NWR and planners and biologists from the Regional Office in Ft. Snelling, Minnesota. Participants toured Mingo NWR, reviewed its purpose, history, ecology, and management, and discussed the issues and challenges the Refuge faces as well as prospects for their resolution.

Subsequently, in November 2003, Regional Office staff held a planning team meeting in Ft. Snelling with contractor Mangi Environmental, which would be assisting with the planning process and CCP preparation; Refuge staff from Mingo NWR participated by teleconference. The planning team discussed upcoming events like the Mingo NWR open house (scoping) meetings and Mingo NWR focus group workshop tentatively scheduled for early January 2004. The planning team decided to hold three scoping meetings and one focus group meeting to cover Mingo NWR alone, as well as one more each for Pilot Knob NWR and Ozark Cavefish NWR, due to the distance between these units.

1.6.1 Mingo NWR Scoping

The planning team conducted two public open houses/scoping meetings, one agency meeting, and one all-day focus group meeting during January 8-10, 2004. The first scoping meeting was conducted in the small town of Puxico close to the Refuge and the second was arranged for the larger town of Poplar Bluff about half an hour away. The Puxico meeting was very well-attended, but no one came to the Poplar Bluff meeting, which was held on a Friday night. Both the agency scoping meeting and the all-day focus group meeting were held in Mingo NWR's headquarters/visitor center.

Comments made and issues broached at the Puxico scoping meeting included the following:

Swamp rabbit habitat improvement need more early successional habitat "openings" in forest canopy
Rockhouse Marsh – set back willows
Provide additional manpower, more maintenance assistance – down from 5 full time and 2-3 temps to 2 fulltime and 1 temp
Control coyotes
Otter and beaver control
Examine economic affects to local community
Solicit cooperation (good will) of folks west of us and north of Refuge
Push for disabled, woman, and youth hunts, turkey hunt on Mingo NWR
No firearms on Refuge
Plant more crops (such as rice) to increase number of ducks to hunt – get local farmers to do this
Use similar management strategy to Otter Slough to increase the amount of ducks on the Refuge
Hayrides to be done as an opportunity for environmental education
Horses, cultural/historic bases on Refuge with educational possibilities (see wildlife up close)
Local folks have influence in Refuge's direction
Rotate Archery hunt area
Increase hunter education related to: species, safety through Hunting clinics
Canal or Pond in Monopoly from May Pond to Ditch 6 (East-West) to act as a refuge for fish during drawdowns
Fish passage at spillway, borrow Ditch at Moccasin Flats tie back into St. Francis and Ditch 15 Reconect St. Francis and Old Mingo River spillway
Multiuse trails – equestrian along roadways and levees (horse, hike, bike) include riding along ditches
Bow Hunt continued on Mingo deer and turkey – special hunts, designated area, youth too
More food in M.S.U. need to plant more crops (rice), land leveling
Leave opened fields open, don't plant more trees
Keep note: temporal, spatial, taxonomic, and geomorphic reference. Recognize process that drive system historically and current status due to modifications made in the system. Understand where we are now, realistic.
Special hunts – not equal use of Refuge.

Attendees at the agency scoping meeting included representatives from Rural Development, the Missouri Department of Conservation (MDOC), Army Corps of Engineers (COE) from Lake Wappapello, Mingo Job Corps, and the University Forest. Meeting participants discussed ongoing cooperative efforts, which they would like to continue. An example of this cooperation is Public Lands Day, a educa-

tional/recreational partnership between the USFWS, USFS, and COE. Duck hunting at Lake Wappapello is affected by Mingo NWR habitat, hunting, and management decisions. Wappapello also has 33 miles of horse-accessible trails.

MDOC's Duck Creek WMA adjacent to the Refuge has a "symbiotic relationship" with Mingo NWR guided by an MOA between the two institutions. Management and is shared with Mingo NWR. Overall, the MDOC spokeswoman indicated that Duck Creek WMA is quite satisfied with its Mingo NWR relationship.

The University Forest started in 1947; it's about 20-25 minutes away from Mingo NWR. The Forest has an outdoor education center with rustic cabins, a dining hall, and a classroom building used by a variety of customers. Some 35 MS and PhD dissertations have been based on research conducted at the Forest. It also has a NADP (National Acid Deposition Program) lab, at which rain, water and soil samples are taken for pH. They regularly send visitors to the Refuge on field trips.

Other issues discussed by the agencies and Mingo NWR staff included air quality, contaminants like mercury, control of invasive species such as nutria, and mitigation for the New Madrid floodway.

The Mingo NWR focus group meeting lasted all day Saturday, January 10, 2004. A total of 25-30 people attended a morning and an afternoon session focused on public use and habitat management, respectively. The following list includes those comments and suggestions most often raised in the open house, focus group and on the comment forms:

Expanding bow hunting desirable
Hunting needs to recruit non-traditional participants (handicapped, women)
Off Road horseback riding desirable
Fishing – enhancing/restoring Red Mill Pond
Cleaning out ditches desirable
No more planting trees on fields
Forest cutting to open areas for waterfowl/ swamp rabbit
Clean and rehabilitate the Rockhouse Marsh.
Fix and update signs and fences.
Grass management so the public can view wildlife.
Keep equipment up to date and maintained adequately.
Multi-use trails that allows for equestrians use.
Equestrians are willing to help with development and maintenance of multi use trails.
Need to plant more crops on Refuge.
No modern firearms.
Open up more farming.
Old pastures in farm rotation.
Rotate bow from east side to west side.
Restore fishing.
Open more area for bow hunting.
Deer control important.

The emphasis in these comments was about equally divided between habitat/wildlife management and public use. Maintenance issues were a distant third.

Further discussion of these issues and concerns can be found in Chapter 2 of the CCP and Chapter 2 of this EA.

1.6.2 Pilot Knob NWR Scoping

Open houses were held for Pilot Knob and Ozark Cavefish NWRs the week of January 12, 2004.

The following comments were gathered at the Tuesday, January 13, 2004 open house meeting for Pilot Knob National Wildlife Refuge:

Make Pilot Knob National Wildlife Refuge more accessible with roads and trails, and possibly an agreement with other agencies.
The area could be made accessible safely.
Open the Refuge to hunting and other public uses.
Work on ways to protect the Indiana bat and allow for some level of accessibility for the public.
Pilot Knob has a 360-degree vista which is unique in the area. Placement of an observation platform depends on its purpose (i.e. scenic, historic, etc…).
Explore alternative fencing techniques for keeping people away from the mine entrance to protect the bats and for public safety, but allow access to the rest of the Refuge.
Consider seasonal closure of the Refuge to accommodate public use of the sites.
Any public use plan would have to consider the bats and public safety.
Need additional financing to fund methods for protecting bats and allowing public use.

- # The area has unique geology.
- # Develop a local body to assist in the management of the Refuge.
- # Better policing of the area would help reduce illegal use. Consider a cooperative arrangement with the Missouri Department of Conservation (or others) to help.
- # Explore interagency agreement with Missouri Department of Conservation to manage Pilot Knob.
- # Examine original agreement with mining company to learn stipulations regarding management of the property.
- # Inform the public about the existence of the Refuge.
- # There is an opportunity to provide information on geology to the public.
- # Add the Refuge to the state natural area system.

Additional discussion of these issues and concerns can be found in Chapter 2 of the CCP and Chapter 2 of this EA.

1.6.3 Ozark Cavefish NWR Scoping

The following comments were gathered at the Monday, January 12, 2004 open house meeting for Ozark Cavefish National Wildlife Refuge:

- # Expand the Refuge to include other Ozark Cavefish sites and provide protection to the adjoining watersheds.
- # Acquire land from willing sellers within the recharge area for Turnback Creek.
- # Consider adding Sercoxie Cave as part of the Refuge.
- # A 10 acre parcel to the north of the Refuge contains the federally threatened Missouri bladderpod and may have a willing seller.
- # The watershed area for the Refuge is about 30 square miles.
- # Hazardous materials spills along Highway 44 are a threat to the Refuge.
- # Place highway signs to indicate motorists are within an Ozark Cavefish recharge area. Examples of such signs can be found along Highway 71 south of Neosho.
- # Work with adjoining land owners to achieve objectives.
- # Work with Kelly Srigiley-Werner who runs the USFWS private lands program in Missouri and has worked on a number of projects for threatened and endangered species.
- # Work with Missouri Department of Conservation and their private lands program.
- # MDOC has an Ozark Cavefish Action Plan and is mapping recharge areas for known Ozark Cavefish sites (the Refuge is ranked second in priority).
- # The greatest protection efforts for Ozark Cavefish would come from conserving recharge areas.
- # Look for ways to mitigate spills along highways within recharge areas.
- # Ozark cavefish are found in subterranean habitats, not just caves.
- # Use environmental education to improve public knowledge of hazards to Ozark Cavefish.
- # Work with Missouri Department of Conservation term employee that administers the private lands program regarding threatened and endangered species.
- # Explore cooperative management options with Missouri Department of Conservation.
- # Consider establishing a field station in the local area.
- # Add staff to focus on Ozark Cavefish NWR and the surrounding area.
- # Consider leasing the property to the Missouri Department of Conservation through a Memorandum of Understanding or a similar agreement.
- # Consider opening the Refuge to public use.
- # Keep Refuge closed to public use.
- # Keep vehicular and foot traffic away from the spring and its spring branch
- # There does not appear to be any threat to the integrity of the Refuge by providing public use.
- # The most frequent inquiry made of the Missouri Department of Conservation regarding the Refuge is about public access.
- # Lack of local Service law enforcement makes it a challenge to enforce closure.
- # Allowing public use would be good for public relations.
- # Missouri Department of Conservation is monitoring Ozark Cavefish sites every other year.
- # State listed crayfish and amphipod may also occur on the Refuge.

- # The subterranean nature of the Ozark Cavefish makes it difficult to determine their distribution and abundance.
- # Consider placing interpretive signing regarding Ozark Cavefish.
- # Control exotic species within the Refuge.
- # Work with The Nature Conservancy's subterranean biodiversity program.
- # There may be opportunities for bladder pod restoration on the Refuge.
- # Improve and expand riparian habitats along Turnback Creek
- # Pursue restoration of the open bottomland component to a wet prairie.

Further discussion of these issues and concerns can be found in Chapter 2 of the CCP and Chapter 2 of this EA.

Chapter 2: Description of the Alternatives

2.1 Formulation of Alternatives

The CCP planning team developed management alternatives for each of the refuges based on the issues, concerns and opportunities raised during the CCP scoping process. The issues that are discussed came from individuals, local citizens and officials, cooperating agencies, conservation organizations and refuge staff. Summaries of the three alternatives are provided in Table 1 on page 116, Table 2 on page 137 and Table 3 on page 139. The following management alternatives were developed to generally fit within the current refuges' budget. In other words, the alternatives were formulated under the assumption that a large budget increase for refuge operations is unlikely during the life of the plan. If an alternative calls for one program to increase in size or scope other refuge programs may need to be reduced. However, the alternatives do consider the possibility of new private resources (volunteers, grant funds, etc.) and a modest refuge program and/or staff funding increase.

2.1.1 Alternative 1: Current Management Direction (No Action)

Under this alternative, Mingo NWR would continue the current direction of managing habitat, wildlife and people. In pursuing the habitat goal, Alternative 1 would manage habitats largely as they are managed at present. Over the next 15 years, it would maintain the rate and volume of water movement at 2005 levels within Ditch 1, Ditch 2, Ditch 5, and Ditch 11, totaling approximately 10 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow.

Under Alternative 1, 15,000 acres of forest would be managed over the long term (100-200 years) to achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL, with lower elevations dominated by bald cypress and water tupelo, mid elevations dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, the Refuge would ensure that approximately 20 percent (with a long term target of 40 percent) of stands presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys.

Current management direction would maintain 3,300 acres of open marsh. Over the next 15 years, it would maintain 2,400-acre Monopoly Marsh and 900-acre Rockhouse Marsh as open water habitat comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*).

Open water (excluding ditches) under this alternative would consist of 9.2 miles of streams and 200 acres of other open water. Over the next 15 years, the Refuge would maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Gum Stump, Stanley Creek, Mingo River, Lick Creek, and Cow Creek.

Over the next 15 years, Alternative 1 would manage 16 Moist Soil Units totaling 704 acres to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.); panic grass (*Panicum* spp.); sedges (*Cyperus* spp. and *Carex* spp.); and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Fredericksson (1992). In addition, the Refuge would maintain 474 acres of grassy openings, 411 acres of cropland, and 95 acres of food plots.

Staff would treat up to 150 acres of invasive/exotic/nuisance plants annually in Alternative 1. The Refuge would annually work to slow the spread and if feasible eliminate exotic or invasive vegetation within the Refuge. Chief focus would be Johnson grass, Sericea lespedeza, bull thistle, reed canary grass, autumn olive, and multiflora rose.

Alternative 1 also includes several objectives related to wildlife. Mingo NWR would continue existing migratory bird monitoring and population management, including conducting waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys. With regard to fish and other aquatic species, over the next 15 years, the

Refuge would create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches. Currently there is no monitoring of reptiles and amphibians, and this would continue to be the case with the current management direction objective. Staff would continue working to slow the spread of undesireable animals within the Refuge. Of present concern are nutria, beaver, and feral hogs. The objective for white-tailed deer management would be to sustain a healthy population ranging from 800-1200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile).

All public uses and visitor service opportunities – including consumptive and non-consumptive recreation – currently enjoyed at Mingo NWR would be maintained under the No Action Alternative. The Refuge would allow for approximately 3,700 hunting visits per year, providing participants with minimal conflicts with other user groups. It would also offer 3,000 sport fishing visits per year, providing anglers minimal conflicts with other user groups.

Mingo NWR would provide a range of wildlife observation and photography opportunities for approximately 65,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups. The Auto Tour Route would be open daily during April, May, October, and November and one week in August for Puxico Homecoming Celebration. Existing environmental education and interpretive activities would be retained over the 15-year life of the CCP. For instance, the Visitor Center would continue to operate with exhibits during week days year round and on weekends from March 1 to June 30 and September 1 to November 30.

Mingo NWR would also permit other compatible recreational and consumptive uses under this alternative. Upon plan approval, the Refuge would provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edibles for a total of 2,200 visits per year.

Mingo NWR would pursue several objectives under the goal of protecting resources, facilities, and visitor safety. With regard to archeological, cultural, and historic resource protection, over the life of the plan, management would avoid disturbance to all known cultural, historic, or archeological sites (presently more than 140 sites). The Refuge would also aim to maintain the wild character and environmental quality of the Mingo Wilderness Area, a Class I air quality area. Over the life of the plan, the Refuge would strive to keep water and airborne contaminants within Missouri Department of Natural Resources and Environmental Protection Agency standards.

With regard to visitor and employee safety, for the duration of the CCP, the objective would be to maintain annual incidents at or below 20 per 100,000 visits. Staff would aim to limit the amount of illegal activities on the Refuge to one incident per 60 hours of law enforcement effort.

Recognizing that Mingo NWR is not an island isolated from the surrounding landscape, another goal is to preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries. Under Alternative 1, the objective for reducing sedimentation from off-Refuge sources would be to decrease the amount of sediment entering the Refuge to levels to be determined within 10 years of plan approval. There is also an objective on Rural Economic Development and Easements: over the life of the plan, Mingo NWR staff would work to ensure compliance of conservation easements on 17 off-Refuge sites totaling 448 acres.

Finally, throughout the life of the plan, staff would strive to establish the Refuge as a sound investment that adds value through natural resource management. This objective would be pursued through a variety of strategies, including the cultivation of good relations with local neighbors, officials, and the media, and cooperation with organizations like The Nature Conservancy and Mingo Job Corps on habitat improvement projects.

2.1.2 Alternative 2: Expanded Public Use

Under Alternative 2, Mingo NWR would emphasize augmenting visitor services and expanding of public use facilities and opportunities on the Refuge. In pursuing the habitat goal, Alternative 2, like the No Action Alternative (1), would generally manage habitats as they are managed at present, except in cases where changes in habitat management are directly related to proposed changes in public use.

With respect to the drainage ditch system, over the next 15 years, this alternative would maintain the rate and volume of water movement at or above 2005 levels within a portion of Ditch 10 and all of Ditches 1, 2, 3, 5, 6, and 11, totaling approximately 34 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow. Mingo NWR would maintain the rate and volume of water movement at or above 2005 levels

within the remaining ditches based on measurements of water flow, sedimentation rates, and duration of flooding.

In the case of forest management, Alternative 2 is identical to Alternative 1. Alternative 2 would manage 15,000 acres of forest over the long term (100-200 years) to achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL, with lower elevations dominated by bald cypress and water tupelo, mid elevations dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, the Refuge would ensure that approximately 20 percent (with a long term target of 40 percent) of stands presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys.

The current management direction would also prevail on 3,300 acres of open marsh in Alternative 2. Over the next 15 years, this alternative would maintain 2,400-acre Monopoly Marsh and 900-acre Rockhouse Marsh as open water habitat comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*).

Open water (excluding ditches) under this alternative would consist of 9.2 miles of streams and 220 acres of other open water, which is 20 acres more than in the No Action Alternative. Over the next 15 years, the Refuge would maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Gum Stump, Stanley Creek, Mingo River, Lick Creek, and Cow Creek. Within five years of CCP approval, Alternative 2 would increase the amount of open water by 20 acres within the Binford Unit as well as increase the amount of structure within Fox Pond.

Over the next 15 years, Alternative 2 would manage 16 Moist Soil Units totaling 704 acres to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.); panic grass (*Panicum* spp.); sedges (*Cyperus* spp. and *Carex* spp.); and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Fredericksen (1992). In addition, the Refuge would maintain 474 acres of grassy openings, 411 acres of cropland, and 95 acres of food plots. This alternative is the same as Alternative 1 in regard to the area and management of both moist soil units and agricultural areas.

Under Alternative 2, staff would treat up to 150 acres of invasive/exotic/nuisance plants annually. The Refuge would annually work to slow the spread and if feasible eliminate exotic or invasive vegetation within the Refuge. Chief focus would be Johnson grass, Sericea lespedeza, bull thistle, reed canary grass, autumn olive, and multiflora rose.

Like the other alternatives, Alternative 2 includes several objectives related to management of wildlife. Within three years of plan approval, this alternative would implement a monitoring program to establish abundance, population trends, and habitat associations of selected migratory bird species or groups of species (e.g. waterfowl, migrating land birds, shorebirds, marsh birds).

Mingo NWR would continue existing migratory bird monitoring and population management, including conducting waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys. In addition, the Refuge would carry out a number of other strategies, including the maintenance of artificial nesting structures for environmental education and wildlife viewing opportunities of cavity nesting species.

With regard to fish and other aquatic species, under this alternative, over the next 15 years, the Refuge would create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches; within four years reintroduction of extirpated, native species (of present interest is alligator gar) would begin to help restore aquatic ecosystems to historic conditions. Reintroduction of the alligator gar would provide added sport fishing opportunities as well as restore a critical component of the aquatic ecosystem.

Currently there is no monitoring of reptiles and amphibians. Within 3 years of plan approval, Alternative 2 would implement a monitoring program to establish abundance, population trends, and habitat associations of selected reptile and amphibian species. This alternative would also monitor reptile and amphibian migration mortality from vehicles using the Auto Tour Route and would modify the opening and closure of the route to minimize this mortality.

With regard to undesirable animals such as the nutria, feral hogs, and beaver, the Refuge would annually work to maintain the levels at or below levels to be determined within 2 years of plan approval. One of the strategies that would be pursued by Alternative 2 would be to promote incidental hunting of hogs if their population expands.

As with Alternative 1, the objective for white-tailed deer management under Alternative 2 would be to sustain a healthy population ranging from 800-1200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile).

Since the thrust of Alternative 2 is to expand public use opportunities, visitor services would generally increase from those available in Alternative 1. For example, with regard to hunting, within four years of plan approval, Mingo NWR would provide approximately 4,200 hunting visits per year, providing participants with minimal conflicts with other user groups. This is an increase of 500 annual visits from the Current Management Direction Alternative (1). A number of new hunting opportunities would be made available under this alternative:

an archery hunt in the wilderness area in alternating years
self-regulated waterfowl hunting in Pool 8 under certain conditions
a lengthened squirrel season

Alternative 2 would aim to expand fishing opportunities from those provided by Alternative 1. Its objective is to offer 4,500 fishing visits per year (increased from 3,000 per year) within four years of plan approval, providing participants with minimal conflicts with other user groups. Among other strategies to achieve the fishing objective, Alternative 2 would construct a 20-acre pond in the Binford Unit by 2010 that would include disabled access and be available for special events. This alternative would also add accessible fishing piers at Flat Banks Entrance Area, Burris Bridge, Ditch 1, May Pond, and Fox Pond.

Under this alternative, Mingo NWR would provide an expanded range of wildlife observation and photography opportunities for approximately 75,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups. The Auto Tour Route would be open daily from March 1 to November 30 except for closure during State firearm deer season and as needed during reptile and amphibian migrations. In addition, the Auto Tour Route would be opened for selected events during winter months (December 1 to end of February). Other strategies from this alternative include installing a webcam for remote viewing of Refuge, maintaining existing and providing additional foot bridges to improve access to the Refuge, and providing a photo blind/observation site.

Environmental education opportunities would increase under Alternative 2. Within 4 years of plan approval, Mingo NWR would establish an environmental education program that provides a diverse balance of educational topics to over 2,000 students annually. Strategies to accomplish this include offering environmental education workshops for teachers, working with scouting groups on merit badge projects, and increasing off-site outreach to attract more visitors.

Interpretation would receive increased emphasis under Alternative 2. Within 4 years of plan approval, Mingo NWR would incorporate the agency mission and the purposes of the Refuge into all direct contacts and ensure that 75 percent of self-guided interpretive programming contains this message. A number of strategies would be used. The Visitor Center would continue to be open with exhibits during week days year round and would extend operations to include weekends from March 1 to November 30. Also, interpretive panels would be developed at Monopoly Overlook. Mingo NWR would also complete renovation of the Boardwalk Nature Trail. Other proposals under Alternative 2 include:

a historic "living history" programming such as timber harvest with mules;
additional interpretive programming along the Auto Tour Route;
inserting more information on reptiles and amphibians in interpretive materials;
within 1 year of CCP approval, initiating effort to work closely with Friends group and other regional, statewide, and/or national conservation organizations to assume management of environmental education program on Refuge.

Mingo NWR would also permit other compatible recreational and consumptive uses under Alternative 2. The Refuge would provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edibles for up to 2,300 visits per year. Among other strategies, Alternative 2 would prohibit motorized traffic along

the access road that runs from Monopoly Overlook to Fox Pond to provide for horseback riding, recreational biking, hiking, jogging, and fishing. Alternative 2 would also maintain all picnic tables and grills.

With Alternative 2, Mingo NWR would pursue several objectives under the goal of protecting resources, facilities, and visitor safety. With regard to archeological, cultural, and historic resource protection, over the life of the plan, management would avoid disturbance to all known cultural, historic, or archeological sites (presently more than 140 sites). The Refuge would also aim to maintain the wild character and environmental quality of the Mingo Wilderness Area, a Class I air quality area. One strategy would be to install a Webcam at a location on the edge of the Wilderness Area that shows daily and seasonal habitat changes and recreational activities. This alternative would also seek to install photo monitoring sites that encompass the Monopoly Basin to help monitor air quality. Over the life of the plan, the Refuge would strive to keep water and airborne contaminants within Missouri Department of Natural Resources and Environmental Protection Agency standards.

With regard to visitor and employee safety, for the duration of the CCP, the objective would be to maintain annual incidents at or below 20 per 100,000 visits. To protect resources, staff would aim to limit the amount of illegal activities on the Refuge to one incident per 60 hours of law enforcement efforts. Boundary and interpretive signage and distribution of Refuge-specific regulatory information would increase, and the Refuge would conduct electronic surveillance and install electric fences at gates.

With regard to the goal to preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries, under Alternative 2, the objective for reducing sedimentation from off-Refuge sources would be to decrease the amount of sediment entering the Refuge to levels to be determined within 10 years of plan approval, which is the same as for Alternative 1. Several additional strategies would be tried under Alternative 2. As with Alternative 1, Alternative 2 includes an objective on Rural Economic Development and Easements: over the life of the plan, Mingo NWR staff would work to ensure compliance of conservation easements on 17 off-Refuge sites totaling 448 acres. Mingo NWR would enhance efforts for compliance reviews and restoration opportunities by conducting annual site inspections and reviews on at least nine easements.

Finally, throughout the life of the plan, Mingo NWR staff would strive to establish the Refuge as a sound investment that adds value through natural resource management. Under Alternative 2, this objective would be pursued through a variety of strategies, including the cultivation of good relations with local neighbors, officials, and the media, and coordination with Friends and other users groups (e.g. Wild Turkey Federation, Ducks Unlimited, Audubon, Wilderness Society etc.) to actively explore opportunities to promote compatible wildlife-dependent recreation on the Refuge. Mingo NWR staff would endeavor to demonstrate precisely what would be gained for the Refuge and the local community if sufficient support were to be received. Also, to assist with the costs of public use administration and infrastructure improvements, there would be a year-round fee system.

2.1.3 Alternative 3: Expanded Habitat Management and Reduced Visitor Conflicts

Under Alternative 3, Mingo NWR would emphasize expanding habitat management and reducing visitor conflicts on the Refuge generally by curtailing the amount and extent of public use.

With respect to the drainage ditch system, over the next 15 years, this alternative, like Alternative 2, would maintain the rate and volume of water movement at or above 2005 levels within a portion of Ditch 10 and all of Ditches 1, 2, 3, 5, 6, and 11, totaling approximately 34 miles, by ensuring that at least 75% of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow. Mingo NWR would maintain the rate and volume of water movement at or above 2005 levels within the remaining ditches based on measurements of water flow, sedimentation rates, and duration of flooding.

In the case of forest management, Alternative 3 is similar to Alternatives 1 and 2. Like the two previous alternatives, Alternative 3 would manage Refuge forests over the long term (100-200 years) to achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL, with lower elevations dominated by bald cypress and water tupelo, mid elevations dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, the Refuge would ensure that approximately 20 percent (with a long-term target of 40 percent) of stands presently domi-

nated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys. Alternative 3 differs from Alternatives 1 and 2 by applying the forgoing management to 16,205 acres rather than 15,000, the increase coming from the conversion of open marsh and other open habitats to bottomland forest.

Alternative 3 would reduce the area of open marsh from 3,300 acres, as it is in Alternatives 1 and 2, to 3,075 acres, with the difference (225 acres in Monopoly Marsh) being converted to wet forest dominated by bald cypress and water tupelo (as just noted above). On this remaining acreage, management would be the same as Alternatives 1 and 2. Over the next 15 years, Alternative 3 would maintain approximately 3,075 acres of open marsh habitat within Rockhouse Marsh (900 acres) and Monopoly Marsh (2,175 acres) comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*).

Open water (excluding ditches) under Alternative 3 would consist of 9.2 miles of streams and 180 acres of other open water. Over the next 15 years, this alternative would maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Stanley Creek, Mingo River, Lick Creek, and Cow Creek, and decrease the amount of open water in Gum Stump.

Over the next 15 years, Alternative 3 would manage 16 Moist Soil Units totaling 704 acres to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.); panic grass (*Panicum* spp.); sedges (*Cyperus* spp. and *Carex* spp.); and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Fredericksson (1992). This objective is identical to those of Alternatives 1 and 2, though some of the strategies would differ.

Alternative 3 would convert all grassy openings, cropland, and food plots to bottomland hardwoods. Within 15 years, it would develop a soft edge – a vegetative gradient from open to forested habitats – along the perimeters of these areas. One strategy of this alternative would be to plant mast trees to speed succession of open areas.

Under Alternative 3, staff would treat up to 150 acres of invasive/exotic/nuisance plants annually, the same as Alternative 1. Staff would annually work to maintain exotic or invasive vegetation on the Refuge at or below levels to be determined within two years of plan approval (of present concern are Johnson grass (*Sericea lespedeza)*, bull thistle, reed canary grass, autumn olive, and multiflora rose). The Refuge would use mechanical, chemical, and biological controls to slow the spread of invasive plant species.

Like the other alternatives, Alternative 3 includes various objectives focused on wildlife management. Within three years of plan approval, this alternative would implement a monitoring program to establish abundance, population trends, and habitat associations of selected migratory bird species or groups of species (e.g. waterfowl, migrating land birds, shorebirds, marsh birds). Mingo NWR would continue existing migratory bird monitoring and population management, including conducting waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys. Under Alternative 3, Mingo NWR would conduct pre and post bird monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.

With regard to fish and other aquatic species, under this alternative, over the next 15 years, under Alternative 3, the Refuge would create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches; within 4 years reintroduction of extirpated, native species (of present interest is alligator gar) would begin to help restore aquatic ecosystems to historic conditions. Reintroduction of the alligator gar would provide added sport fishing opportunities as well as restore a critical component of the aquatic ecosystem. By 2008, Alternative 3 would also conduct a comprehensive aquatic resources survey in cooperation with MDC.

Currently there is no monitoring of reptiles and amphibians. Within 3 years of plan approval, Alternative 3 would implement a monitoring program to establish abundance, population trends, and habitat associations of selected reptile and amphibian species. This alternative would also monitor reptile and amphibian migration mortality from vehicles using the Auto Tour Route and would modify the opening and closure of the route to minimize this mortality. Alternative 3 would provide or enhance vernal pool habitat. The Refuge would also conduct pre and

post- monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.

With regard to undesirable animals such as the nutria, feral hogs, and beaver, the Refuge would annually work to maintain the levels at or below levels to be determined within 2 years of plan approval. One of the strategies that would be pursued by Alternative 3 is to consider the use of trapping to reduce feral hog numbers in cooperation with MDC and neighbors.

As with Alternatives 1 and 2, the objective for white-tailed deer management under Alternative 3 would be to sustain a healthy population ranging from 800-1200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile). One of the several strategies proposed would be to monitor Refuge exclosures for signs of habitat damage that would indicate that carrying capacity has been surpassed.

Since the thrust of Alternative 3 is to expand habitat management, not public use opportunities, visitor services would generally be identical or similar to those available in Alternative 1, Current Management Direction (the No Action Alternative). The Refuge would allow for approximately 3,700 hunting visits per year, providing participants with minimal conflicts with other user groups. One point of difference with Alternative 1 is that Alternative 3 would offer waterfowl hunting on Pool 8 when the water level reaches a suitable elevation by providing a maximum of 40 individuals through daily drawing.

Like Alternative 1, Alternative 3 would also offer 3,000 sport fishing visits per year, providing anglers minimal conflicts with other user groups. Fishing would be permitted from March 1 to September 30 in the area north of Ditch 11 between and including Ditch 2 and Ditch 6. It would be available year-round on Ditch 1, Ditch 2, Ditch 6, Ditch 11, Mingo River, Job Corps Lake, Stanley Creek, May Pond, Fox Pond, and Red Mill Pond.

Like Alternative 1, Alternative 3 would provide a range of wildlife observation and photography opportunities for approximately 65,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups. However, several strategies under Alternative 3 do differ from Alternative 1. For instance, the Auto Tour Route would be open daily during April, May, October, and November and 1 week in August for Puxico Homecoming Celebration, but would close during State firearm deer season and as needed during reptile and amphibian migrations. Also, from October 1 to March 1, the area between Ditch 4 and Ditch 6 south of Monopoly Marsh would be closed to all public use to provide an area for wildlife that is free of disturbance.

Under Alternative 3, environmental education and interpretation opportunities would increase. Within 4 years of plan approval, Mingo NWR would establish an environmental education program that provides a diverse balance of educational topics to over 2,000 students annually. Within 4 years of plan approval, Mingo NWR would incorporate the agency mission and the purposes of the Refuge into all direct contacts and ensure that 75 percent of self-guided interpretive programming contains this message. Otherwise these programs would remain much as they are under the No Action Alternative, except that their focuses would shift to wildlife and habitat management themes.

Mingo NWR would also permit certain other compatible recreational and consumptive uses under Alternative 3. Upon plan approval, the Refuge would provide compatible opportunities for horseback riding, canoeing, biking, hiking, and jogging for a total of 1,725 visits per year. Alternative 3 would eliminate gathering of wild edibles.

Among other things, this alternative would offer horseback riding, recreational biking, hiking, and jogging along 13 miles of the Auto Tour Route when it is closed to vehicular traffic and along 6 miles of Bluff Road year-round. Alternative 3 would also offer these uses along Red Mill Drive from March 1 to September 30. In addition, this alternative would phase out all picnic tables and grills.

With Alternative 3, as with other alternatives, Mingo NWR would pursue several objectives under the goal of protecting resources, facilities, and visitor safety. With regard to archeological, cultural, and historic resource protection, over the life of the plan, management would avoid disturbance to all known cultural, historic, or archeological sites (presently more than 140 sites). This alternative would also complete a Phase I archeological surveys of the non-flooded areas of the Refuge, by qualified personnel, as a necessary first step in cultural resources management.

The Refuge would aim to maintain the wild character and environmental quality of the Mingo Wilderness Area, a Class I air quality area. One strategy would be to install a Webcam at a location on the edge of the Wilderness Area that shows daily and seasonal habitat changes and recreational activ-

ities. Another strategy is to conduct air and water quality monitoring within the Wilderness Area (e.g. mercury contamination). This alternative would also seek to install photo monitoring sites that encompass the Monopoly Basin to help monitor air quality. Alternative 3 would also ensure that one or more of the Refuge staff have received Service training in wilderness management, including Minimum Tool Analysis. Mimicking natural hydrology within the Wilderness Area is an additional aim. Over the life of the plan, the Refuge would strive to keep water and airborne contaminants within Missouri Department of Natural Resources and Environmental Protection Agency standards.

With regard to visitor and employee safety, for the duration of the CCP, the objective would be to maintain annual incidents at or below 20 per 100,000 visits. To protect resources, staff would aim to limit the amount of illegal activities on the Refuge to one incident per 60 hours of law enforcement effort. Boundary and interpretive signage and distribution of Refuge-specific regulatory information would increase, and the Refuge would conduct electronic surveillance and install electric fences at gates.

With regard to the goal to preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries, under Alternative 3, the objective for reducing sedimentation from off-Refuge sources would be to decrease the amount of sediment entering the Refuge to levels to be determined within 10 years of plan approval, which is the same as for Alternative 1. Alternative 3 would pursue a number of strategies beyond those proposed under Alternative 1. For example, it would partner with MDC, the Little River Drainage District and private landowners to reduce sediment entering the Refuge by implementing projects upstream on watersheds entering the Refuge. In addition, Mingo NWR would concentrate conservation efforts along Stanley Creek, Kawker Creek, Brush Creek, McGee Creek, Slage Creek, Cane Creek, Dry Creek, Malone Creek, Glassed Creek, and Lick Creek.

As with Alternatives 1 and 2, Alternative 3 includes an objective on Rural Economic Development and Easements. Over the life of the plan, Mingo NWR staff would work to ensure compliance of conservation easements on 17 off-Refuge sites totaling 448 acres. Mingo NWR would enhance efforts for compliance reviews and restoration opportunities by conducting annual site inspections and reviews on at least nine easements. The Refuge would also increase cooperation with FSA in visiting new sites with potential wildlife or habitat value.

Finally, throughout the life of the plan, Mingo NWR staff would strive to establish the Refuge as a sound investment that adds value through natural resource management. Under Alternative 3, this objective would be pursued through a variety of strategies, including the cultivation of good relations with local neighbors, officials, and the media, and cooperation with organizations like The Nature Conservancy and Mingo Job Corps on habitat improvement projects. Mingo NWR staff would endeavor to demonstrate precisely what would be gained for the Refuge and the local community if sufficient support were to be received. Also, to assist with the costs of public use administration and infrastructure improvements, there would be a year-round fee system.

2.1.4 Alternative 4: Balanced Expanded Public Use and Habitat Management (Preferred Alternative)

Alternative 4 would pursue both expanded public use and habitat management in a balanced approach that would seek to increase the benefits of the Refuge in all respects. It is the Refuge's and the Service's preferred alternative, and is the basis for the CCP to which this EA is attached.

With respect to the drainage ditch system, over the next 15 years, this alternative, like Alternatives 2 and 3, would maintain the rate and volume of water movement at or above 2005 levels within a portion of Ditch 10 and all of Ditches 1, 2, 3, 5, 6, and 11, totaling approximately 34 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow. The Refuge would maintain the rate and volume of water movement at or above 2005 levels within the remaining ditches based on measurements of water flow, sedimentation rates, and duration of flooding. A total of 11 strategies would be pursued in the effort to attain this objective, including placing a water control structure on Ditch 10.

In the case of forest management, Alternative 4 is similar to Alternatives 1, 2 and 3. Like the three previous alternatives, Alternative 4 would manage Refuge forests over the long-term (100-200 years) to achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL, with lower elevations dominated by bald cypress and water tupelo, mid eleva-

tions dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, the Refuge would ensure that approximately 20 percent (with a long-term target of 40 percent) of stands presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys. Alternative 4 would apply the forgoing management to 15,547 acres. This is more than the 15,000 acres of Alternatives 1 and 2, but less than the 16,205 acres of Alternative 3. The increase comes from the conversion of open marsh and other open habitats to the bottomland forest. The amount is less than that in Alternative 3 because fewer acres of grassy openings, cropland, and food plots would be converted.

Alternative 4, like Alternative 3, would reduce the area of open marsh from 3,300 acres in Alternatives 1 and 2 to 3,075 acres, with the difference (225 acres in Monopoly Marsh) being converted to wet forest dominated by bald cypress and water tupelo (as just noted above). On this remaining acreage, management would be the same as Alternatives 1 and 2. Over the next 15 years, Alternative 4 would maintain approximately 3,075 acres of open marsh habitat within Rockhouse Marsh (900 acres) and Monopoly Marsh (2,175 acres) comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*).

Open water (excluding ditches) under Alternative 4 would consist of 9.2 miles of streams and 200 acres of other open water, which is the same as the No Action Alternative, but 20 acres fewer of open water than Alternative 2 and 20 acres more open water than Alternative 3. Over the next 15 years, this alternative would maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Stanley Creek, Mingo River, Lick Creek, and Cow Creek, and decrease the amount of open water in Gum Stump. Within 5 years of CCP approval, the amount of open water would be increased by 20 acres within the Binford Unit and the amount of structure increased within Fox Pond.

Over the next 15 years, Alternative 4 would manage 15 Moist Soil Units totaling 653 acres to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.); panic grass (*Panicum* spp.); sedges (*Cyperus* spp. and *Carex* spp.); and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Fredericksson (1992). This objective is identical to those of Alternatives 1, 2, and 3, though some of the strategies would differ.

Alternative 4 would convert 449 acres of grassy openings, cropland, and food plots to cane, oak savanna, and young bottomland forests, early successional habitats that would benefit species such as quail, turkey, doves, and swamp rabbits. Within 15 years, Mingo NWR would develop a soft edge – a vegetative gradient from open to forested habitats – along the perimeters of these areas, and replace fescue with native vegetation.

Under Alternative 4, staff would treat up to 150 acres of invasive/exotic/nuisance plants annually, the same as with all other alternatives. Staff would annually work to maintain exotic or invasive vegetation on the Refuge at or below levels to be determined within two years of plan approval (of present concern are Johnson grass, Sericea lespedeza, bull thistle, reed canary grass, autumn olive, and multiflora rose). The Refuge would use mechanical, chemical, and biological controls to slow the spread of invasive plant species.

Like the other alternatives, Alternative 4 includes various objectives focused on wildlife management. Within three years of plan approval, this alternative would implement a monitoring program to establish abundance, population trends, and habitat associations of selected migratory bird species or groups of species (e.g. waterfowl, migrating land birds, shorebirds, marsh birds). Mingo NWR would continue existing migratory bird monitoring and population management, including conducting waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys. Under Alternative 4, Mingo NWR would conduct pre and post bird monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.

With regard to fish and other aquatic species, under this alternative, over the next 15 years, under Alternative 4, the Refuge would create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches; within 4 years reintroduction of extirpated, native species (of present interest is alligator gar) would begin to help restore aquatic

ecosystems to historic conditions. Reintroduction of the alligator gar would provide added sport fishing opportunities as well as restore a critical component of the aquatic ecosystem. By 2008, Alternative 4 would also conduct a comprehensive aquatic resources survey in cooperation with MDC.

Currently there is no monitoring of reptiles and amphibians at Mingo NWR. Within 3 years of plan approval, Alternative 4 would implement a monitoring program to establish abundance, population trends, and habitat associations of selected reptile and amphibian species. This alternative would also monitor reptile and amphibian migration mortality from vehicles using the Auto Tour Route and would modify the opening and closure of the route to minimize this mortality. Alternative 4 would provide or enhance vernal pool habitat. The Refuge would also conduct pre and post- monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.

With regard to undesirable animals such as the nutria, feral hogs, and beaver, the Refuge would annually work to maintain the levels at or below levels to be determined within 2 years of plan approval. One of the strategies that would be pursued by Alternative 4 is to consider the use of trapping to reduce feral hog numbers in cooperation with MDC and neighbors. This alternative would also promote incidental hunting of hogs if the population expands.

As with each of the other alternatives, the objective for white-tailed deer management under Alternative 3 would be to sustain a healthy population ranging from 800-1200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile). One of the several strategies proposed would be to monitor Refuge exclosures for signs of habitat damage that would indicate that carrying capacity has been surpassed.

Since Alternative 4 expands public use opportunities over those currently available, visitor services would generally increase from those available in Alternative 1 and be more comparable to those of Alternative 2 (Expanded Public Use). With respect to hunting, within 4 years of plan approval, Mingo NWR would provide approximately 4,200 hunting visits per year, providing participants with minimal conflicts with other user groups. This is an increase of 500 annual visits from the Current Management Direction Alternative (1). A number of new hunting opportunities would be made available under this alternative:

Refuge-hosted hunter education courses.
Host participants of MDC's Spring Turkey Women's Outdoor Skills Event within the public hunting area.
Offer an education-based fall youth firearms deer hunt within the public hunting area.
Waterfowl hunting on Pool 8 as follows: when the water level reaches a suitable elevation; provide a maximum of 40 individuals through daily drawing.

Alternative 4 would expand fishing opportunities from those provided by Alternative 1. Its objective is to offer 4,500 fishing visits per year (increased from 3,000 per year) within 4 years of plan approval, providing participants with minimal conflicts with other user groups. Among other strategies to achieve the fishing objective, Alternative 4 would construct a 20-acre pond in the Binford Unit by 2010 that would include disabled access and be available for special events. This alternative would also add accessible fishing piers at Flat Banks Entrance Area, Burris Bridge, Ditch 1, May Pond, and Fox Pond.

Under this alternative, Mingo NWR would provide an expanded range of wildlife observation and photography opportunities for approximately 75,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups. The Auto Tour Route would be open daily from March 1 to November 30 except for closure during State firearm deer season and as needed during reptile and amphibian migrations. In addition, the Auto Tour Route would be opened for selected events during winter months (December 1 to end of February). Other strategies from this alternative include installing a webcam for remote viewing of Refuge, maintaining existing and providing additional foot bridges to improve access to the Refuge, and providing a photo blind/observation site.

Environmental education opportunities would increase under Alternative 4. Within 4 years of plan approval, Mingo NWR would establish an environmental education program that provides a diverse balance of educational topics to over 2,000 students annually. Strategies to accomplish this include offering environmental education workshops for teachers, working with scouting groups on merit badge projects, and increasing off-site outreach to attract more visitors.

Interpretation would receive increased emphasis under Alternative 2. Within 4 years of plan approval, Mingo NWR would incorporate the

agency mission and the purposes of the Refuge into all direct contacts and ensure that 75 percent of self-guided interpretive programming contains this message. A number of strategies would be used. The Visitor Center would continue to be open with exhibits during week days year-round and would extend operations to include weekends from March 1 to November 30. Also, interpretive panels would be developed at Monopoly Overlook. Mingo NWR would also complete renovation of the Boardwalk Nature Trail. Other proposed strategies under Alternative 4 include:

- a historic "living history" programming such as timber harvest with mules;
- an additional interpretive programming along the Auto Tour Route;
- developing one or more exhibits on reptiles and amphibians for the Visitor Center;
- developing an annual wildlife festival.

Mingo NWR would also permit other compatible recreational and consumptive uses under Alternative 4. The Refuge would provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edible plants for a total of 2,300 visits per year. Among other things, Alternative 4 would offer gathering of one-half gallon per day of mushrooms and berries and 5 gallons per day of pokeweed for personal use and without ground disturbance in the areas south of Ditch 11 and east of Ditch 6 from Marsh 1st to September 30th. Possession or harvest outside this area would be prohibited. Alternative 4 would also phase out all picnic tables and grills.

With Alternative 4, as with other alternatives, Mingo NWR would pursue several objectives under the goal of protecting resources, facilities, and visitor safety. With regard to archeological, cultural, and historic resource protection, over the life of the plan, management would avoid disturbance to all known cultural, historic, or archeological sites (presently more than 140 sites). This alternative would also complete a Phase I archeological surveys of the non-flooded areas of the Refuge, by qualified personnel, as a necessary first step in cultural resources management.

The Refuge would aim to maintain the wild character and environmental quality of the Mingo Wilderness Area, a Class I air quality area. One strategy would be to install a webcam at a location on the edge of the Wilderness Area that shows daily and seasonal habitat changes and recreational activities. Another strategy is to conduct air and water quality monitoring within the Wilderness Area (e.g. mercury contamination). This alternative would also seek to install photo monitoring sites that encompass the Monopoly Basin to help monitor air quality. Alternative 4 would also ensure that one or more of the Refuge staff have received Service training in wilderness management, including Minimum Tool Analysis. Mimicking natural hydrology within the Wilderness Area is an additional aim. Over the life of the plan, the Refuge would strive to keep water and airborne contaminants within Missouri Department of Natural Resources and Environmental Protection Agency standards.

On the question of visitor and employee safety, for the duration of the CCP, the objective for Alternative 4 would be to maintain annual incidents at or below 20 per 100,000 visits. To protect resources, staff would aim to decrease the amount of illegal activities on the Refuge to one incident per 60 hours of law enforcement effort. Boundary and interpretive signage and distribution of Refuge-specific regulatory information would increase, and the Refuge would conduct electronic surveillance and install electric fences at gates.

With regard to the goal to preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries, under Alternative 4, the objective for reducing sedimentation from off-Refuge sources would be to decrease the amount of sediment entering the Refuge to levels to be determined within 10 years of plan approval, which is the same as for each alternative. However, Alternative 4, like Alternative 3, would pursue a number of strategies beyond those proposed under Alternative 1. For example, it would partner with MDC, the Little River Drainage District and private landowners to reduce sediment entering Refuge by implementing projects upstream on watersheds entering the Refuge. In addition, Mingo NWR would concentrate conservation efforts along Stanley Creek, Kawker Creek, Brush Creek, McGee Creek, Slage Creek, Cane Creek, Dry Creek, Malone Creek, Glassed Creek, and Lick Creek.

As with Alternatives 1, 2 and 3, Alternative 4 includes an objective on Rural Economic Development and Easements: over the life of the plan, Mingo NWR staff would work to ensure compliance of conservation easements on 17 off-Refuge sites totaling 448 acres. Mingo NWR would enhance efforts for compliance reviews and restoration opportunities by conducting annual site inspections

and reviews on at least nine easements. The Refuge would also increase cooperation with FSA in visiting new sites with potential wildlife or habitat value.

Finally, throughout the life of the plan, Mingo NWR staff would strive to establish the Refuge as a sound investment that adds value through natural resource management. Under Alternative 4, this objective would be pursued through a variety of strategies, including the cultivation of good relations with local neighbors, officials, and the media, and cooperation with organizations like The Nature Conservancy and Mingo Job Corps on habitat improvement projects. Mingo NWR staff would endeavor to demonstrate precisely what would be gained for the Refuge and the local community if sufficient support were to be received. Also, to assist with the costs of public use administration and infrastructure improvements, there would be a year-round fee sytem.

2.1.5 Alternative(s) Considered But Not Developed

The CCP planning team also considered the alternative of returning the Refuge to its original, pre-settlement condition. Attempting to restore Mingo NWR's pre-settlement condition would mean restoring it to the state it was in prior to large-scale logging, beginning as far back as the 1880s, followed by widespread draining, burning, and livestock grazing in the 20th century. To implement this alternative and meet its goals, all impoundments and dikes would have to be removed and ditches filled in. A variation on this alternative would be to simply let "nature take its course" on the drainage ditch network and various impoundments, not bothering to repair breaches in levee or dikes and not removing accumulating sediments from the drainage ditches.

The planning team dismissed this alternative and its variation on the grounds that they would be contrary to the Refuge purpose of serving as a resting and wintering area for migratory waterfowl. If all active habitat management and intervention were to cease, it is likely that much of Mingo basin would fill with sediments eroded by upstream land uses and that all open water, cypress swamps, and greentree reservoirs would disappear, replaced by dense thickets that provide habitat and foraging for some wildlife species, but not migratory waterfowl. This outcome would be unacceptable.

2.2 Comparison of Management Alternatives

Table 1 on page 116 compares each of the four proposed management alternatives by objective and strategy.

2.3 Pilot Knob National Wildlife Refuge

The planning team developed two management alternatives for Pilot Knob NWR: 1) Current Management Direction (No Action), and 2) Expand Species Protection and Opportunities for the Public. Each is summarized below in turn. These alternatives address most of the issues, concerns, and opportunities identified in the CCP scoping process. Specific impacts of implementing each alternative will be examined in three broad issue categories:

Protection of the Indiana Bat: Does the management approach provide for the protection of this population of a federally endangered species that lives in the abandoned iron mine shafts?

Public Use: Can the demand for public use of the Refuge be accommodated without harming the Indiana bat and endangering visitors?

Refuge Administration and Management: Due to the distance from Mingo NWR (90 miles), there is not a sufficient management presence at Pilot Knob. The low visibility of Refuge managers there contributes to lack of community support and coordination on local issues. How can this support and coordination best be achieved while Pilot Knob continues to be managed from Mingo NWR?

2.3.1 Alternative 1: Current Management Direction (No Action)

The first goal of the Pilot Knob CCP is contributing to the recovery of federally listed species and the conservation of their subterranean habitat on the Refuge and the first objective under this goal relates to law enforcement. In Alternative 1, law enforcement activities at Pilot Knob NWR would remain infrequent. Several activities would be pursued, however. These include defining and upgrading existing access or acquire a new access to the Refuge; repairing fencing and maintain boundary signs to help reduce illegal access; tracking law enforcement reports to detect trends in illegal activity at the Refuge; and issuing and monitoring special use permits.

The second objective under the first goal for Pilot Knob NWR relates to recovery of the Indiana bat and gray bat. Under Alternative 1, Refuge staff would work with the Missouri Department of Conservation, Missouri Department of Natural Resources, and other partners to implement state and federal recovery plans for these species.

The second goal for Pilot Knob NWR is that local residents and visitors are aware of the Refuge and its purpose. The objective under Alternative 1 for this goal is to limit visits to those associated with research or education and requiring special use authorization. The only strategy that would be pursued under this objective is to establish a minimally developed administrative/ maintenance access road passable by a four-wheel drive vehicle for implementing public use activities.

2.3.2 Alternative 2: Expand Species Protection and Opportunities for the Public

Under the first goal of contributing to the recovery of federally listed species and the conservation of subterranean habitat on the Refuge, and the first objective of law enforcement, throughout the life of the plan Alternative 2 would limit documented incidents of illegal activity to one incident per 60 hours of law enforcement effort. To achieve this objective, Alternative 2 would carry out each of the strategies listed under Alternative 1, but would add two others: developing a cooperative agreement with the Missouri Department of Conservation to share law enforcement on the Refuge, and initiating a Friends group or similar body to act as a "neighborhood watch" organization to assist in monitoring activity on the Refuge.

The second objective under Pilot Knob NWR's first goal relates to recovery of the Indiana bat and the gray bat. Alternative 2 would include the same recovery plan efforts as Alternative 1, but would also include:

Placing barriers to restrict access to the abandoned mine entrance
Investigating ways to stabilize the abandoned mine entrance
Working with the Indiana Bat Recovery Team on monitoring protocol.

The second goal for Pilot Knob NWR is that local residents and visitors are aware of the Refuge and its purpose. The related objective for Alternative 2 would be to allow guided access to the Refuge for up to 100 visitors per year within 5 years of plan approval. A number of strategies are proposed to help attain this objective, among others: developing a Refuge brochure; exploring a partnership with Fort Davidson State Historic Site to assist with guided tours; exploring a seasonal closure of the Refuge to avoid disturbing hibernating bats; and evaluating the feasibility and compatibility of an observation platform on the summit of Pilot Knob.

2.3.3 Alternative(s) Considered But Not Developed

The planning team considered several other alternatives but dismissed them from more detailed consideration because of one or more "fatal flaws." Allowing for unrestricted access by the public to Pilot Knob was considered, but this was rejected on the basis of its strong potential to adversely affect a federally listed endangered species. Turning over management and ownership of Pilot Knob National Wildlife Refuge to MDC was also considered, but dismissed because of the federal government's primary responsibility for species protected under the federal Endangered Species Act. Finally, the alternative of developing a permanent Refuge headquarters, staff presence, and public facilities independent and distinct from Mingo National Wildlife Refuge was considered, but dismissed on the grounds of its excessive cost and staffing limitations.

2.3.4 Comparison of Management Alternatives

Table 2 on page 137 compares the two proposed management alternatives for Pilot Knob National Wildlife Refuge by objective and strategy.

2.4 Ozark Cavefish National Wildlife Refuge

The planning team developed two management alternatives for Ozark Cavefish NWR: 1) Current Management Direction (No Action), and 2) Expand Species Protection and Opportunities for the Public. Each is summarized below in turn. These alternatives address most of the issues, concerns, and opportunities identified in the CCP scoping process. Specific impacts of implementing each alternative will be examined in three broad issue categories:

Protection of the Ozark Cavefish: Does the management approach provide for the protection of this population of a federally endangered species that lives in Turnback Creek Cave? Will the Refuge be able to take measures and cooperate with partners to protect the water quality of Turnback Creek from

possible contamination that could harm the Ozark cavefish?

Public Use: Can public use of the Refuge be accommodated with harming the Ozark cavefish?

Other Rare Species: How can the Refuge contribute to the conservation of other rare species of flora and fauna, such as the federally threatened Missouri bladder pod?

2.4.1 Alternative 1: Current Management Direction (No Action)

The first goal of the Ozark Cavefish CCP is contributing to the recovery of federally listed species and the conservation of other subterranean species and their habitats within the Springfield Plateau. The first objective under this goal relates to habitat management. In Alternative 1, there would continue to be no active habitat management.

The second objective under Ozark Cavefish's first goal relates to visitor services and public awareness. Presently, there is no active promotion of the Refuge other than a brochure and webpage and the situation would remain thus throughout the lifetime of the CCP. Under Alternative 1, the Refuge would maintain a Web cam at Hearrell Spring portion of Refuge.

With regard to law enforcement, the third objective under the first goal, under Alternative 1 there would be to continue to be infrequent law enforcement inspections. The Refuge would, however, post and maintain its boundaries to minimize accidental trespass.

The second goal for Ozark Cavefish NWR is to have landowners in the recharge areas of the Refuge apply best management practices to maintain water quality. Under Alternative 1, presently there is no active program to improve water quality within the recharge areas for Turnback Creek or Hearrell Springs, and this would continue to be the case.

2.4.2 Alternative 2: Expand Species Protection and Opportunities for the Public

The first goal of the Ozark Cavefish CCP is contributing to the recovery of federally listed species and the conservation of other subterranean species and their habitats within the Springfield Plateau. The first objective under this goal relates to habitat management. In Alternative 2, within 10 years of plan approval, the Refuge would document historic conditions, collect current data on vegetation composition consistent with standards of the National Vegetation Classification System, and identify opportunities for habitat restoration. Three strategies under Alternative 2 would support attaining this objective: developing a cooperative agreement with MDC to share management oversight of the Refuge; developing and beginning to implement a Habitat Management Plan; and adding a 0.5 FTE (half-time) Refuge Operations Specialist (5/7/9) to oversee Refuge management including habitat management, implementing recovery plans, building and maintaining partnerships, and managing visitor services.

The second objective under the first goal relates to visitor services and public awareness. Under Alternative 2, within 10 years of plan approval, 50% of a randomly selected sample of residents within the Turnback Creek and Hearrell Spring recharge areas will recognize the purpose of the Refuge. This objective is supported by a number of strategies, including the development of a cooperative agreement with Missouri Department of Conservation and Neosho National Fish Hatchery to share public use management and oversight of the Refuge and installing educational/interpretive kiosks at Hearrell Spring and Turnback Creek portions of Refuge.

With regard to law enforcement, the third objective under the first goal under Alternative 2, the Refuge would strive to limit incidents of illegal activity to one incident per 60 hours of law enforcement effort throughout the life of the plan. To that end, the Refuge would both post and maintain Refuge boundaries and develop a cooperative agreement with MDC to share law enforcement oversight of the Refuge.

The second goal for Ozark Cavefish NWR is to have landowners in the recharge areas of the Refuge apply best management practices to maintain water quality. The only objective under this goal relates to conservation of the recharge area. In Alternative 2, at least 75 percent of landowners in the Turnback Creek recharge area will be presented with information regarding the relationship between best management practices and water quality and encouraged to apply the practices. Five strategies support this objective, including working with the Service's Partners for Wildlife program and the Missouri Department of Conservation's private lands programs to develop a landowner education program, and working with MDC, the Missouri Department of Natural Resources, the Missouri Department of Transportation, landowners, and

others to develop mitigation measures for hazardous materials spills.

2.4.3 Alternative(s) Considered But Not Developed

The planning team considered several other alternatives but dismissed them from more detailed analysis because of one or more deficiencies. Turning over ownership of Ozark Cavefish National Wildlife Refuge to MDC was also considered, but dismissed because of the federal government's primary responsibility for species protected under the federal Endangered Species Act. Finally, the alternative of developing a permanent field station, full-time or part-time staff presence stationed on the Refuge, and public facilities independent and distinct from Mingo National Wildlife Refuge was considered, but dismissed on the grounds of its excessive cost and staffing limitations.

2.4.4 Comparison of Management Alternatives

Table 3 on page 139 compares the two proposed management alternatives for Ozark Cavefish National Wildlife Refuge by objective and strategy.

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Goal 1: Habitat **The Refuge will actively conserve a mosaic of upland and wetland habitats, including designated wilderness, through appropriate management strategies that preserve, protect, and enhance the vitality and health of the natural environment.**				
Objective 1: Ditch System				
Amount: 10 miles	X			
Activity: Over the next 15 years, maintain the rate and volume of water movement at 2005 levels within Ditch 1, Ditch 2, Ditch 5, and Ditch 11, totaling approximately 10 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow.	X			
Amount: 34 miles		X	X	X
Activity: Over the next 15 years, maintain the rate and volume of water movement at or above 2005 levels within a portion of Ditch 10 and all of Ditches 1, 2, 3, 5, 6, and 11, totaling approximately 34 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow. Maintain rate and volume of water movement at or above 2005 levels within the remaining ditches based on measurements of water flow, sedimentation rates, and duration of flooding.		X	X	X
Strategies:				
1. Use an excavator to remove sediment from the ditches and pile it along adjacent banks.	X	X	X	X
2. Seek funding and full-time (1.0 FTE) heavy equipment operator to accelerate the rate of sediment removal.		X	X	X
3. Within 3 years of CCP approval, develop MOU between Mingo and Duck Creek Wildlife Management Area to manage water jointly, both for public use and habitat management.		X	X	X
4. Maintain thorough records of when each reach of each ditch was cleaned out. Monitor depths and widths of ditches over time to assess rate of future sedimentation and develop a timetable for systematic ditch maintenance.	X	X	X	X
5. Continually investigate possible ways of speeding up ditch cleaning or making it more efficient.		X	X	X
6. Repair, replace and upgrade water control structures (converting to bottom draw) as needed, including Ditch 2 pump.		X	X	X
7. Consider hiring a professional hydrologist and conducting an elevation survey to guide improvements to the drainage network.		X	X	X
8. Maintain levees after silt removal to provide maintenance access.		X	X	X
9. Plant cover crops on levees for wildlife use.		X	X	X
10. Place water control structure along Ditch 10.			X	X
11. Maintain spring drainage so that system is flushed from bottom of water column.	X	X	X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Objective 1-2: Forest				
Amount: 15,000 acres	X	X		
Amount: 16,205 acres (increase comes from conversion of open marsh and other open habitats)			X	
Amount: 15,547 acres (increase comes from conversion of open marsh and other open habitats)				X
Amount:Over the long term (100-200 years), achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL with lower elevations dominated by bald cypress and water tupelo, mid elevations dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, ensure that approximately 20 percent (with a long term target of up to 40 percent) of stands presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys.	X	X	X	X
Strategies				
Green Tree Reservoirs				
1. Continue to flood three Green Tree Reservoirs (Pools 5, 7, and 8), totaling 3,040 acres, for no more than 130 consecutive days between November and March. Drain water prior to growing season to encourage regeneration and avoid killing trees.	X	X		
2. Continue to flood three Green Tree Reservoirs (Pools 5, 7, and 8), totaling 3,040 acres, for no more than 130 consecutive days between November and March. Drain water prior to growing season to encourage regeneration and avoid killing trees. Under dry conditions may hold water in Green Tree Reservoirs into spring.			X	X
Bottomland Hardwoods (includes Green Tree Reservoirs)				
3. Conduct forest surveys or inventories every 5 years to monitor changes in health, composition, and structure of lowland and upland forests.	X	X	X	X
4. Develop and implement 5-year forest management plan.	X	X	X	X
5. Manage timber to promote regeneration of willow oak, pin oak, and red oak.			X	X
6. As indicated, conduct forest management activities such as thinning dense stands or midstory and selective harvest on a small scale to allow for habitat diversity and opening of canopy to stimulate plant growth, regeneration and recruitment on forest floor.			X	X
7. Provide vernal pools where feasible.			X	X
8. In Pool 8, on ridges at elevations 338 to 339 or above possessing the potential for pin or willow oak regeneration, selectively remove gum, maple, elm, overcup, and other undesirables. Reevaluate annually to ensure success. After 5-7 years, reevaluate and potentially remove the upper canopy oak and other species to release light and promote the growth of willow and pin oak.			X	X
9. Allow water levels to fluctuate between mid-December to April. Have areas flooded no more than 130 consecutive days between November and March.			X	

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
10. Conduct a study to learn more about the hydrology and geomorphology of the Refuge.			X	X
Objective 1-3: Open Marsh				
Amount: 3,300 acres	X	X		
Activity: Over the next 15 years, maintain 2,400-acre Monopoly Marsh and 900-acre Rockhouse Marsh as open water habitat comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*).	X	X		
Amount:3,075 acres			X	X
Activity: Over the next 15 years, maintain approximately 3,075 acres of open marsh habitat within Rockhouse Marsh (900 acres) and Monopoly Marsh (2,175 acres) comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*), and convert approximately 225 acres of Monopoly Marsh from open marsh habitat to wet forest dominated by bald cypress and water tupelo.			X	X
Strategies				
1. Draw down Monopoly Marsh (2,400 acres) once every five years shrinking flooded area to 30 acres.	X	X	X	X
2. Draw down Monopoly Marsh incrementally over years to progressively expose edge habitats allowing for eventual conversion of about 225 acres to bald cypress and water tupelo.			X	X
3. Draw down Rockhouse Marsh (900 acres) to 334 feet msl by May 15 every other year, and remove woody vegetation (willow) during drawdown. Reflood marsh beginning on October 1.	X	X	X	X
4. Accelerate removal of willow and promote fluctuating water levels via enhanced water level control capability.		X	X	X
5. Restore ingress/egress fish (and other aquatic species) passages to both marshes.			X	X
6. Consider that Monopoly Marsh is located within Wilderness Area and manage accordingly, i.e. through use of minimal tools.	X	X	X	X
7. Conduct vegetation surveys every 5 years to gauge success of reforestation along perimeter of Monopoly Marsh			X	X
8. Conduct vegetation surveys every 2 years to monitor expansion of emergent vegetation in the basin including cut grass.			X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Objective 1-4: Open Water (excluding ditches)				
Amount: 9.2 miles of streams; 200 acres of other open water	X			X
Amount: 9.2 miles of streams; 220 acres of other open water		X		
Amount: 9.2 miles of streams; 180 acres of other open water			X	
Activity: Over the next 15 years, maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Gum Stump, Stanley Creek, Mingo River, Lick Creek, and Cow Creek.	X			
Activity: Over the next 15 years, maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Gum Stump, Stanley Creek, Mingo River, Lick Creek, and Cow Creek. Within 5 years increase the amount of open water by about 20 acres within the Binford Unit and increase the amount of structure within Fox Pond.		X		
Activity: Over the next 15 years, maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Stanley Creek, Mingo River, Lick Creek, and Cow Creek, and decrease the amount of open water in Gum Stump.			X	
Activity: Over the next 15 years, maintain the amount of open water at or above 2005 levels within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Stanley Creek, Mingo River, Lick Creek, and Cow Creek, and decrease the amount of open water in Gum Stump. Within 5 years increase the amount of open water by about 20 acres within the Binford Unit and increase the amount of structure within Fox Pond.				X
Strategies:				
1. Continue to manage ponds, pools, and impoundments using the appropriate tools such as periodic drawdowns, vegetation removal, and levee and structure maintenance.	X	X	X	X
2. Ensure appropriate consultation and cooperation between fishery biologists and engineers in construction of open water on Binford Unit and in the rehabilitation of Hartz Pond.		X		X
3. Use tree drops in some ponds to create habitat structure and fish cover.		X	X	X
4. By 2010, construct about 20 acres of open water at Binford Unit to provide additional fishing opportunities.		X		X
5. By 2010, rehabilitate Hartz Pond for fishing opportunities.		X		X
Objective 1-5: Moist Soil Units				
Amount: 16 units totaling 704 acres	X	X		
Amount: 15 units totaling 653 acres			X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Activity: Over the next 15 years, manage Moist Soil Units to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.); panic grass (*Panicum* spp.); sedges (*Cyperus* spp. and *Carex* spp.); and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Frederickson (1992).	X	X	X	X
Strategies:				
1. Disturb (through mowing, disking, fire, etc…) an average of one third of Moist Soil Unit acreage annually to set back succession.	X	X	X	X
2. Moist soil units will be maintained in early successional native plant communities for the production of annual seed crops.	X	X	X	X
3. Flood Moist Soil Units in stages beginning in October or November, initially flooding one-third and progressively flooding more of each unit as waterfowl deplete the food supply until units are entirely inundated.	X	X	X	X
4. Begin draining in March to expose mudflats by April to benefit migrating shorebirds which can feed on invertebrates.	X	X	X	
5. Maintain MSUs dry throughout the growing season to produce food for migratory birds.	X	X	X	X
6. Maintain pumps, dikes and water control structures in good working order.	X	X	X	X
7. Maintain units to demonstrate comparison practices for educational purposes.	X	X	X	X
8. Replace water control structures and slope sides of borrow pits, thereby increasing opportunities for wildlife observation and environmental education and research.		X		X
9. Develop waterfowl public educational seminars and tours course conducted by Leigh Frederickson and Micky Heitmeyer.		X		X
10. Develop MOU with MDC on management of Moist Soil Unit 11 (Luken Farm).			X	X
11. Explore land exchange with MDC for Luken Farm property.			X	X
12. Provide additional fall-flooded, shallow-water habitat for shorebirds when feasible.			X	X
13. Maintain stable water levels at 1 to 6 inches across 80 to 90 acres of moist soil units from March through July 31 and encourage a mosaic of moist soil plants such as soft-stem bulrush (*Schoenoplectus tabernaemontani*), giant cutgrass (*Zizaniopsis miliacea*), prairie cordgrass (*Spartina pectinata*) and cattail (*Typus* spp.) to provide medium height cover (2-6 feet) interspersed with small areas of mud flats and shallow depressions as nesting habitat for King Rails.			X	X
14. With the exception of those acres managed for Black Rail and King Rail, begin draining moist soil units in March to expose mudflats by April to benefit migrating shorebirds which can feed on invertebrates.			X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
15. Maintain stable water levels of 1 inch or less across 10 to 20 acres of moist soil units from April through August 15, and encourage a vegetative monotype of *Eleocharis* spp. (spikerushes), sedges, or other wetland/wet prairie grasses that provide dense low cover (2 feet or less) interspersed with small areas of mudflats and shallow depressions to provide nesting habitat for Black Rails.			X	X
16. Annually disturb the 10 to 20 acres of moist soil managed for Black Rails to remove unwanted vegetation while maintaining level ground capable of providing stable water levels of 1 inch or less.			X	X
Objective 1-6: Grassy Openings, Cropland, and Food Plots				
Amount: 980 acres	X	X		
Activity: Annually maintain 474 acres of grassy openings, 411 acres of cropland, and 95 acres of food plots.	X	X		
Amount: 0 acres			X	
Activity: Convert all grassy openings, cropland, and food plots to bottomland hardwoods. Within 15 years, develop a soft edge—a vegetative gradient from open to forested habitats—along the perimeters of these areas.			X	
Amount: 531 acres				X
Activity: Maintain 531 acres of the existing 980 acres of grassy openings, cropland, and food plots. Convert the remaining 449 acres to cane (15 acres), oak savanna (112 acres), and young bottomland forest (322 acres), early successional habitats that would benefit species such as quail, turkey, doves, and swamp rabbits. Within 15 years, develop a soft edge—a vegetative gradient from open to forested habitats—along the perimeters of these areas, and replace fescue with native vegetation.				X
Strategies:				
1. Maintain cooperative agreements, which require cooperating farmers to leave 33 percent of the corn, milo, or 100 percent of winter wheat or clover for wintering waterfowl and resident species.	X	X	X	X
2. Mow fields as often as necessary to set back encroaching woody growth.	X	X		X
3. Provide food sources in upland openings for wildlife use during inclement weather.	X	X		X
4. Utilize mowing/haying to create and maintain forage.	X	X		X
5. Mow or plant food plots to provide for expanded opportunities for wildlife observation by public.	X	X		X
6. Seek partnerships to enhance funding and staffing resources to replace cooperative farming program to maintain open areas and provide early successional edge habitat.	X	X		X
7. Plant mast trees to speed succession of open areas.			X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Objective 1-7: Invasive/Exotic/Nuisance Plants				
Amount: Treat up to 150 acres annually	X	X	X	X
Activity: Annually work to slow the spread and if feasible eliminate exotic or invasive vegetation within the Refuge (of present concern are Johnson grass, *Sericea lespedeza*, bull thistle, reed canary grass, autumn olive, and multiflora rose).	X	X		
Activity: Annually work to maintain exotic or invasive vegetation on the Refuge at or below levels to be determined within 2 years of plan approval (of present concern are Johnson grass, *Sericea lespedeza*, bull thistle, reed canary grass, autumn olive, and multiflora rose).			X	X
Strategies:				
1. Actively communicate with other state and federal resources agencies, as well as non-governmental organizations, to stay abreast of emerging exotic threats, as well as management strategies and techniques.	X	X	X	X
2. Coordinate control strategies with Regional Office and other state and federal agencies.	X	X	X	X
3. Maintain good records of control efforts and results.	X	X	X	X
4. Use mechanical and chemical controls to slow the spread of invasive plant species.	X			
5. Use mechanical, chemical, and biological controls to slow the spread of invasive plant species.			X	X
6. Complete a comprehensive inventory to assess invasive plant infestations.			X	X
Goal 2: The Refuge will provide for a diversity of migratory birds and native fish and wildlife associated with healthy Refuge habitats and contributing to the mission of the National Wildlife Refuge System.				
Objective 2-1: Migratory Bird Monitoring				
Activity: Continue existing migratory bird monitoring and population management.	X			
Activity: Within 3 years of plan approval, implement a monitoring program to establish abundance, population trends, and habitat associations of selected migratory bird species or groups of species (e.g. waterfowl, migrating land birds, shorebirds, marsh birds).		X	X	X
Strategies:				
1. Conduct waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys.	X	X	X	X
2. Conduct shorebird surveys using the International Shorebird Survey Protocol to track occurrence, relative abundance, and response to management regimes.		X	X	X
3. Maintain artificial nesting structures for environmental education and wildlife viewing opportunities of cavity nesting species.		X		

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
4. Develop an Inventory and Monitoring step-down management plan based on direction contained in part 701 FW 2 of the Fish and Wildlife Service Manual	X	X	X	X
5. Partner with conservation and private organizations to assist with monitoring, inventory, and educational efforts.		X	X	X
6. Conduct pre and post bird monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.			X	X
Objective 2-2: Fish/Aquatic Species				
Activity: Over the next 15 years, create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches.	X			
Activity: Over the next 15 years, create or maintain diverse, self-sustaining fisheries in Refuge ponds, streams, and ditches; and within 4 years begin reintroduction of extirpated, native species (of present interest is alligator gar) to help restore aquatic ecosystems to historic conditions.		X	X	X
Strategies:				
1. In cooperation with MDC, conduct annual population censuses of sport fishery using electro-shocking or other techniques.	X	X	X	X
2. Working with MDC, stock catfish and other native game fish in ditches and ponds as needed.	X	X	X	X
3. By 2009, reintroduce alligator gar to provide added sport fishing opportunities and to restore a critical component of the aquatic ecosystem.		X	X	X
4. By 2008, conduct a comprehensive aquatic resources survey in cooperation with MDC.			X	X
5. Improve fisheries resources at Fox Pond by creating a balanced and self-sustaining fishery.		X	X	X
6. Continue removal of barriers and modify existing water control structures to enhance fish passage.	X	X	X	X
7. Use tree drops in ditches at appropriate locations to create habitat structure and fish cover.		X	X	X
8. Work with COE to periodically modify water discharge rates from Wappapello Lake to enhance opportunities for fish passage at Refuge spillway.			X	X
9. By 2015, restore and enhance mussel populations by allowing for reintroduction of host fish, through the modification of the spillway structure.			X	X
Objective 2-3: Reptiles and Amphibians				
Activity: Currently no monitoring of reptiles and amphibians.	X			

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Activity: Within 3 years of plan approval, implement a monitoring program to establish abundance, population trends, and habitat associations of selected reptile and amphibian species.		X	X	X
Strategies:				
1. Monitor reptile and amphibian migration mortality due to vehicular use along Auto Tour Route and modify the opening and closure of the route to minimize mortality.		X	X	X
2. With partners conduct research on mortality, mercury levels, and habitat use and availability.			X	X
3. Provide or enhance vernal pool habitat			X	X
4. Conduct pre and post monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.			X	X
5. Partner with conservation and private organizations to assist with monitoring inventory and educational efforts.			X	X
Objective 2-4: Invasive/Exotic/Nuisance Animals				
Activity: Annually work to slow the spread and if feasible eliminate exotic or invasive animals within the Refuge (of present concern are nutria, beaver, and feral hogs).	X			
Activity: Annually work to maintain levels of exotic or invasive animals on the Refuge at or below levels to be determined within 2 years of plan approval (of present concern are nutria, beaver, and feral hogs).		X	X	X
Strategies:				
1. Control nutria and feral hogs on the Refuge.	X		X	X
2. Promote incidental hunting of hogs if the population expands.		X		X
3. Monitor beaver populations and control nuisance beaver.	X		X	X
4. Document habitat impacts and infrastructure damage caused by beavers, nutria, and feral hogs.			X	X
5. In cooperation with MDC and neighbors, consider the use of trapping to reduce feral hog numbers.	X		X	X
Objective 2-5: White-tailed Deer				
Amount: 24-35 per square mile	X	X	X	X
Activity: Upon plan approval, manage the deer herd to sustain a healthy population ranging from 800-1200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile).	X	X	X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Strategies:				
1. Monitor the size and population density of the deer herd through surveys conducted in December and January and conduct presence/absence survey following closure of bow season.	X	X	X	X
2. Monitor Refuge exclosures for signs of habitat damage that would indicate that carrying capacity has been surpassed.	X	X	X	X
3. Evaluate health of individual animals and herd using standard techniques.	X	X	X	X
Goal 3: Visitor Services: Provide a variety of wildlife-dependent recreational and educational opportunities to allow the public to enjoy the resources of the Refuge and support the National Wildlife Refuge System.				
Objective 3-1: Hunting				
Amount: 3,700 hunting visits	X		X	
Activity: Upon plan approval, provide approximately 3,700 hunting visits per year, providing participants with minimal conflicts with other user groups.	X		X	
Amount: 4,200 hunting visits		X		X
Activity: Within 4 years of plan approval, provide opportunities for approximately 4,200 hunting visits per year while maintaining sustainable resources and providing participants with minimal conflicts with other user groups.		X		X
Strategies:				
1. Manage hunts to minimize conflicts with other uses and resources.	X	X	X	X
2. Maintain good communication with hunters and other user groups so as to minimize conflicts and any friction between different users.	X	X	X	X
3. Host participants of MDC's Spring Turkey Women's Outdoor Skills Event within the public hunting area.		X		X
4. Offer educationally based fall youth firearms deer hunt within the public hunting area.		X		X
5. Conduct archery hunt in the wilderness area in alternating years.		X		
6. Offer waterfowl hunting on Pool 8 as follows: when the water level reaches an elevation of 339.3 feet eliminate the daily drawing and allow an open self-regulated hunt in which hunters sign in/out and record daily bag.		X		
7. Lengthen squirrel season.		X		
8. Offer Refuge hosted hunter education courses.		X		X
9. Offer access to Ditch 3 area by opening Sand Blow Ridge Road year-round except when it is flooded.	X	X		X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
10. Request assistance from MDC for muzzleloader hunt.	X	X		X
11. Participate in State waterfowl drawing held at Duck Creek that includes Pool 8.	X			X
12. Offer waterfowl hunting on Pool 8: when the water level reaches a suitable elevation. Provide a maximum of 40 individuals through a daily drawing.			X	X
13. Require tree stands to be removed at the end of each day's hunt.			X	X
Objective 3-2: Fishing				
Amount: 3,000 fishing visits	X		X	
Activity: Upon plan approval, offer 3,000 fishing visits per year, providing participants minimal conflicts with other user groups.	X		X	
Amount: 4,500 fishing visits		X		X
Activity: Within 4 years of plan approval, offer opportunities for 4,500 fishing visits per year while maintaining sustainable resources and providing participants with minimal conflicts with other user groups.		X		X
Strategies:				
1. Offer fishing from March 1 to September 30 in the area north of Ditch 11 between and including Ditch 2 and Ditch 6.	X	X	X	X
2. Offer fishing year round on Ditch 1, Ditch 2, Ditch 6, Ditch 11, Mingo River, Job Corps Lake, Stanley Creek, May Pond, Fox Pond, and Red Mill Pond.	X	X	X	X
3. Offer fishing from March 1 to September 30 on Ditches 3, 4, 5, Monopoly Marsh, Rockhouse Marsh, and Gum Stump.	X	X	X	X
4. By 2010 construct a recreational fishing pond in the Binford Unit that would include disabled access and be available for special events.		X		X
5. Add accessible fishing piers at Flat Banks Entrance Area, Burris Bridge, Ditch 1, May Pond, Fox Pond.		X		X
6. Add mowed bank fishing access along ditches, Flat Banks, and Pierman Lane when possible.		X		X
7. Offer fishing year round at the Ditch 5 and Ditch 11 water control structures.		X		X
8. Eliminate bow fishing and gigging on the Refuge.			X	X
Objective 3-3: Wildlife Observation and Photography				
Amount: 65,000 visits	X		X	
Activity: Upon plan approval, provide a range of wildlife observation and photography opportunities for 65,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups.	X		X	

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Amount: 75,000 visits		X		X
Activity: Within 5 years of plan approval, provide a range of wildlife observation and photography opportunities for 75,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups.		X		X
Strategies:				
1. Along 13 miles of the Auto Tour Route, offer seasonal vehicle access from April through May; one week during Puxico Homecoming Celebration (presently the second week of August); and October through November.	X			
2. Along 13 miles of the Auto Tour Route, offer seasonal vehicle access from April through May; one week during Puxico Homecoming Celebration (presently the second week of August); and October through November except for closure during State firearm deer season and as needed during reptile and amphibian migrations.			X	
3. Along 13 miles of the Auto Tour Route, offer seasonal vehicle access from March 1 through November 30 except for closure during State firearm deer season and as needed during reptile and amphibian migrations.		X		X
4. Offer year round vehicle access along 6 miles of the Auto Tour Route, and the entire 5-mile length of Red Mill Drive.	X	X	X	X
5. Offer year round vehicle access along the entire 3-mile length of Sand Blow Ridge Road.	X	X		X
6. Offer seasonal vehicle access from May 15 through September 30 on the 1 mile road segment between May Pond and Fox Pond.	X			X
7. Open Auto Tour Route for selected events during winter months (December 1 to end of February).		X		X
8. Offer a number of observation sites and structures that include universally accessible sites.	X	X	X	X
9. Open Monopoly Marsh to public use from March 1 to September 30.	X	X	X	X
10. Install Web Cam for remote viewing of Refuge.		X		X
11. Provide a photo blind/observation site. Potential sites include Red Mill Pond or near Rockhouse Cypress Marsh Overlook.		X		X
12. Maintain or improve opportunities for viewing wildlife at overlooks and at selected open fields and farm units.		X		X
13. Maintain existing and provide additional foot bridges to improve access to the Refuge.		X		X
14. Provide wildlife observation and photography opportunities west of Ditch 6 year round.	X	X		X
15. Provide wildlife observation and photography opportunities east of Ditch 6 to the eastern Refuge boundary from March 1 to September 30.	X	X	X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
16. From October 1 to February 28, close to all public use the area between Ditch 4 and Ditch 6 south of Monopoly Marsh and north of Ditch 11 to provide an area for wildlife that is free of disturbance.			X	X
17. Designate Red Mill Drive as a second auto tour route with interpretive information.		X		X
Objective 3-4: Environmental Education				
Activity: Continue existing environmental education activities.	X			
Activity: Within 4 years of plan approval, establish an environmental education program that provides a diverse balance of educational topics to over 2,000 students annually.		X	X	X
Strategies:				
1. Offer environmental education programs for youth groups, schools, and the general public with a reptile and amphibian focus at times of the year when they are most likely to be seen.		X	X	X
2. Offer teacher workshops for environmental education.		X		X
3. Develop programs specific to Mingo NWR (e.g., ditch systems, snakes, waterfowl).		X	X	X
4. Work with scouting groups on merit badge projects.		X		X
5. Renovate Hartz Pond and trail for environmental education.		X		X
6. Add a full-time (1 FTE) Park Ranger to assist with weekend visitor center operations, programming, special events, and maintenance of visitor facilities.		X	X	X
7. Insert more information on reptiles and amphibians in environmental education materials.		X	X	X
8. Continue to maintain existing environmental educaiton facilities and materials.	X	X	X	X
Objective 3-5: Interpretation				
Activity: Continue existing interpretation activities.	X			
Activity: Within 4 years of plan approval, incorporate the agency mission and the purposes of the Refuge into all direct contacts and 75 percent of self-guided interpretive programs.		X	X	X
Strategies:				
1. Partner with other agencies for special events.	X	X		X
2. Continue to operate Visitor Center with exhibits during week days year-round and extend operations to include weekends from March 1 to November 30.		X		X
3. Develop interpretive panels at Monopoly Overlook.		X		X
4. Complete renovation of the Boardwalk Nature Trail.	X	X		X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
5. Complete observation platform and interpetive panels along Highway 51.	X	X		X
6. Partner with Friends and others to provide guided wildlife interpretive tours.		X		X
7.Develop an annual wildlife festival.		X		X
8. Provide historic "living history" programming such as timber harvest with mules.		X		X
9. Provide additional interpretive programming along the Auto Tour Route.		X		X
10. Develop one or more exhibits on reptiles and amphibians for the Visitor Center.	X		X	X
11. Continue to maintain existing interpretive facilities and materials including the Visitor Center, exhibits, brochures, waysides, etc.	X	X	X	X
12. Increase off-site outreach efforts to attract long-distance visitors.	X	X		X
13. Insert more information on reptiles and amphibians in interpretive materials.		X	X	X
Objective 3-6: Other Compatible Recreational and Consumptive Uses				
Activity: Upon plan approval, provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edible plants for a total of 2,200 visits per year.	X			
Activity: Throughout the life of the plan, provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edible plants for a total of 2,300 visits per year.		X		X
Activity: Upon plan approval, provide compatible opportunities for horseback riding, canoeing, biking, hiking, and jogging for a total of 1,725 visits per year.			X	
Strategies:				
1. Offer year round access for horseback riding, recreational biking, hiking, and jogging along the entire 19-mile length of the Auto Tour Route and along the entire 5-mile length of Red Mill Drive.	X	X		X
2. Along 13 miles of the Auto Tour Route, offer seasonal access from January 1 through March 31, June 1 through the first week of August, the third week of August through September 30, and December for horseback riding, recreational biking, hiking, and jogging.			X	
3. Offer seasonal access from March 1 through September 30 for horseback riding, recreational biking, hiking, and jogging along the entire 5-mile length of Red Mill Drive.			X	
4. Offer year round access for horseback riding, recreational biking, hiking, and jogging along the entire 3-mile length of Sand Blow Ridge Road.	X	X		X
5. Offer seasonal access from March 1 through September 30 for horseback riding, recreational biking, hiking, and jogging along a 6-mile loop between Ditch 3 and Ditch 4.		X		X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
6. Offer seasonal access from May 15 through September 30 for horseback riding, recreational biking, hiking, and jogging on the 1 mile road segment between Monopoly Overlook and Fox Pond.	X	X	X	X
7. Offer year round access for horseback riding, recreational biking, hiking, and jogging along a 6-mile length of Bluff Road.	X	X	X	X
8. Evaluate and authorize horseback riding, recreational biking, canoeing, and jogging involving group events through a permitting process.	X	X	X	X
9. Provide for the regional bike route to pass through the Refuge along existing roads and (improved) levee tops.		X		X
10. Maintain existing hiking trails and canoe trails.	X	X		X
11. Offer gathering of mushrooms, berries, nuts, pokeweed, and fruits for personal use outside of Wilderness Area without ground disturbance.	X	X		
12. Eliminate gathering of wild edibles such as mushrooms, berries, nuts, pokeweed, and fruits. Distribute fliers and add temporary signs to Refuge entrances alerting the public to the closure of the Refuge to wild edibles gathering.			X	
13. Offer gathering of one-half gallon per day of mushrooms and berries and five gallons per day of pokeweed for personal use and without ground disturbance in the areas south of Ditch 11 and east of Ditch 6 from March 1 to September 30. Possession or harvest outside this area is prohibited.				X
14. Maintain existing picnic tables and grills.	X	X		
15. Phase out all grills and concentrate picnic tables near areas of high public use.			X	X
16. Offer boating, canoeing, and kayaking from March 1 to September 30 in the area north of Ditch 11 between and including Ditch 2 and Ditch 6.	X	X	X	X
17. Offer boating, canoeing, and kayaking year round on Ditch 1, Ditch 2, Ditch 6, Ditch 11, Mingo River, Job Corps Lake, Stanley Creek, May Pond, Fox Pond, and Red Mill Pond.	X	X	X	X
18. Offer boating, canoeing, and kayaking from March 1 to September 30 on Ditches 3, 4, 5, Monopoly Marsh, Rockhouse Marsh, and Gum Stump.	X	X	X	X
19. Provide year-round boating access to Ditch 11 at Burris Bridge, and Flat Banks.		X		X
Goal 4: Resource, Facility, and Visitor Safety and Protection : Protect natural, cultural, and man-made resources and provide for the safety of staff, volunteers, and visitors to the extent feasible				
Objective 4-1: Archeological, Cultural, and Historic Protection				
Activity: Over the life of the plan, avoid and protect against disturbance all known cultural, historic, or archeological sites (presently more than 140 sites).	X	X	X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Strategies:				
1. Conduct site-specific surveys prior to ground disturbing projects and protect known archeological, cultural and historic sites.	X	X	X	X
2. Within 10 years of CCP approval, complete a Cultural Resources Management Plan (CRMP) and start to implement recommendations and procedures over the remaining life of the CCP.				X
3. Determine National Register eligibility of known sites.	X	X	X	X
4. Conduct consultations with Missouri State Historic Preservation Officer (SHPO) and Service Regional Historic Preservation Officer to ensure compliance with Section 106 of National Historic Preservation Act.	X	X	X	X
5. Contract with cultural resources firms specializing in Missouri to conduct Phase I surveys prior to undertakings that could adversely affect historic resources.	X	X	X	X
6. In the event of inadvertent discoveries of ancient human remains, follow instructions and procedures indicated by SHPO and RHPO, which would likely include tribal notification and consultation.	X	X	X	X
7. Ensure archeological and cultural values are described, identified, and taken into consideration prior to implementing undertakings.	X	X	X	X
8. Complete Phase I archeological surveys of the non-flooded areas of the Refuge, by qualified personnel, as a necessary first step in cultural resources management.		X	X	X
9. Identify, inventory, preserve, and protect early settler grave sites on the Refuge.		X	X	X
Objective 4-2: Wilderness Area Management and Protection including Research Natural Areas				
Amount: 7,730 acres	X	X	X	X
Activity: Protect and maintain the wilderness and biological character of the 7,730-acre, Class I Mingo Wilderness Area.	X	X	X	X
Strategies:				
1. Preserve and protect wilderness values within area through proper signage, keeping out unauthorized entry, etc.	X	X	X	X
2. Inspect perimeter of Wilderness Area at least once every three years to replace signs that have fallen, disappeared, been damaged or vandalized.	X	X	X	X
3. Inspect interior of Wilderness Area at least once every three years to monitor for habitat changes, succession and any signs of unauthorized human disturbance.	X	X	X	X
4. Install Webcam at a location outside the Wilderness Area that shows daily and seasonal habitat changes and recreational activities.		X	X	X
5. Install photo monitoring sites that encompass the Monopoly Basin to help monitor air quality.		X	X	X

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	Applies to Alternative(s)			
6. Implement the "Leave no Trace" program to teach public about minimizing impacts to Wilderness Area.	X	X	X	X
7. Ensure that one or more of the Refuge staff have received Service training in wilderness management, including Minimum Tool Analysis.			X	X
8. Conduct air and water quality monitoring within the Wilderness Area (e.g. mercury contamination).			X	X
9. Mimic natural hydrology within Wilderness Area.			X	X
Objective 4-3: Contaminants				
Activity: Over the life of the plan, maintain water and airborne contaminants at levels that meet or exceed Missouri Department of Natural Resources and Environmental Protection Agency standards.	X	X	X	X
Strategies:				
1. Conduct monthly drinking water tests to comply with State regulations.	X			
2. Within 5 years of CCP approval, expand program to include monitoring on a regular basis of fish, reptiles and amphibians, sediments, and water quality for contamination by a variety of toxins. Also, conduct monthly drinking water tests to comply with State regulations, and periodically more detailed tests of other contaminants like nitrates, leads, other heavy metals, etc.		X	X	X
3. Ensure that employees collecting different kinds of environmental quality and contaminant samples are adequately trained in standard procedures for sampling.	X	X	X	X
4. Establish sites for repeated sampling to build a baseline of comparable data, and obtain information from other locations to expand breadth of data and reduce risk that localized problems are not being overlooked.			X	X
5. Conduct cooperative research on mercury and other contaminants.	X	X	X	X
Objective 4-4: Visitor and Employee Safety				
Activity: Over the life of the plan, limit reported incidents to 20 per 100,000 visits per year.	X	X	X	X
Strategies:				
1. Provide regular law enforcement patrol, respond to search and rescue cases, and maintain facilities and infrastructure in compliance with OSHA and other regulations, educate public on environmental hazards.	X	X	X	X
2. Continue close cooperation with MDC agents, Stoddard and Wayne County deputies, and State Patrol.	X	X	X	X
3. Continue Refuge sponsored Search and Rescue Team with a designated Refuge Coordinator.	X	X	X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
4. Expand law enforcement patrol.	X	X	X	X
5. Maintain all facilities and infrastructure in compliance with OSHA and other regulations.	X	X	X	X
6. Install electric gates at entrances.		X	X	X
7. Add signage and information in brochure about dangerous wildlife and other Refuge hazards.	X	X	X	X
8. Expand Visitor Center hours to include weekends from March 1 through November 30.		X		X
9. Increase staffing by 0.8 FTE for roadside mowing and facility/road maintenance to provide safe environment for visitors and employees.		X		X
Objective 4-5: Resource Protection				
Activity: Over the life of the plan, limit the amount of documented incidents of illegal activities to 1 incident per 60 hours of law enforcement effort.	X	X	X	X
Strategies:				
1. Continue close cooperation with MDC agents, Stoddard and Wayne County deputies, and State Patrol.	X	X	X	X
2. Enhance relationship with U.S. District Attorney's Office.	X	X	X	X
3. Increase boundary and interpretive signage and distribution of Refuge-specific regulatory information.		X	X	X
4. Conduct electronic surveillance.		X	X	X
5. Develop additional cooperative law enforcement efforts with local, state, and federal law enforcement organizations.		X	X	X
6. Obtain a full-time law enforcement officer.		X	X	X
7. Increase law enforcement efforts to prevent poaching of Refuge resources.	X	X	X	X
8. Revamp Refuge regulations and general activities pamphlets to improve clarity and understanding of Refuge specific regulations.		X	X	X
9. Annually inspect areas where most wild edibles gathering has occurred to check for any habitat damage, erosion, litter, etc.	X	X		X
10. Conduct periodic inspections of sites known to be popular with gatherers and incidental inspections of visitors in those areas carrying bags, baskets or other containers that might be carrying wild edibles.			X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Goal 5: Off Refuge Conservation: Preserve, protect, and enhance Refuge integrity and encourage conservation beyond Refuge boundaries.				
Objective 5-1: Reducing Sedimentation from Off-Refuge Sources				
Activity: Over the life of the plan, decrease the amount of sediment entering the Refuge to levels to be determined within 10 years of plan approval.	X	X	X	X
Strategies:				
1. Over the life of the plan carry out strategic wetland restoration along the watershed of Duck Creek Bottoms.	X		X	X
2. Over life of the plan, expand private landowner duck-hunting and wildlife observation opportunities from wetland restoration along the watershed of Duck Creek Bottoms.		X		X
3. Partner with MDC, Little River Drainage District and private landowners to reduce sediment entering Refuge by implementing projects upstream on watersheds entering the Refuge.			X	X
4. Explore the possibility of using the Wetland Reserve Program or Conservation Reserve Programs to help fund wetland restoration on private lands.	X	X	X	X
5. Approach landowners individually or in a meeting arranged by the Refuge to consider cooperative efforts to carry out wetland restoration.			X	X
6. Try to enlist the support of local, regional, and national waterfowl hunting organizations like Ducks Unlimited.		X	X	X
7. Concentrate conservation efforts along Stanley Creek, Kawker Creek, Brush Creek, McGee Creek, Slage Creek, Cane Creek, Dry Creek, Malone Creek, Glassed Creek, and Lick Creek.			X	X
8. Add 0.5 FTE Biotech to conduct inspections and assist in Wetland Reserve Program and wetland restoration.		X	X	X
9. Identify lands near the Refuge, totaling 10 percent or less of existing Refuge acreage (approximately 2,100 acres), for possible acquisition.			X	X
10. Work with the Natural Resources Conservation Service, Farm Services Agency, and Missouri Department of Conservation to establish conservation easements with land owners in the Stanley Creek watershed.			X	X
11. Use a variety of methods to seed, plant, level or otherwise cover exposed banks and slopes to reduce erosion and sedimentation.			X	X
12. Work with the EPA and others to assess the sedimentation rate and establish acceptable thresholds.	X		X	X
Objective 5-2: Rural Economic Development and Easements				
Amount: 17 sites totaling 448 acres	X	X	X	X

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	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
Activity: Over the life of the plan, ensure compliance of conservation easements.	X			
Activity: Over the life of the plan, ensure compliance of conservation easements and restore and enhance wildlife habitat on 17 sites totaling 448 acres.		X	X	X
Strategies:				
1. Conduct periodic reviews for compliance and restoration opportunities.	X			
2. Enhance efforts for compliance reviews and restoration opportunities by conducting annual site inspections and reviews on at least nine easements.		X	X	X
3. Maintain archive of records, files and photographs for each property to monitor progress towards habitat enhancement.	X	X	X	X
4. Cooperate closely with FSA.	X	X	X	X
5. Increase cooperation with FSA in visiting new sites with potential wildlife or habitat value.			X	X
6. Add 0.5 FTE Biotech to assist with inspections and restoration work on easements.			X	X
7. Use 15 percent of full-time law enforcement officer for compliance inspections.			X	X
Goal 6: Seek opportunities to obtain sufficient human resources and facilities through partner and agency funding mechanisms to achieve the goals and objectives of the CCP.				
Objective 6-1: Refuge				
Activity: Throughout the life of the plan, establish the Refuge as a sound investment that adds value through natural resource management.	X	X	X	X
Strategies:				
1. Cultivate good relations with local neighbors, officials, and the media.	X	X	X	X
2. Document precisely funding needs through memos and reports.	X	X	X	X
3. Conduct site visits for USFWS and other federal officials (e.g. Congressional offices) to showcase Refuge's achievements and needs; select location and time of year that will best highlight these needs and accomplishments.	X	X	X	X
4. Demonstrate precisely what would be gained for the Refuge and the local community if sufficient support were to be received.		X	X	X
5. Utilize the local media to promote Refuge habitat improvements, outreach activities, and other accomplishments.	X	X	X	X
6. Coordinate with Friends and other users groups (e.g. Wild Turkey Federation, Ducks Unlimited, Audubon, Wilderness Society etc.) to actively explore opportunities to promote compatible wildlife-dependent recreation on the Refuge.	X	X	X	X

Table 1: Comparison of Objectives and Strategies By Management Alternatives, Mingo NWR

Goals, Objectives and Strategies	Alternative Themes			
	Current Management Direction (No Action)	Expanded Public Use	Expanded Habitat Management and Reduced Visitor Conflicts	Balanced Expanded Public Use and Habitat Management
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	Applies to Alternative(s)			
7. Cooperate with organizations like The Nature Conservancy and Mingo Job Corps on habitat improvement projects.	X		X	X
8. Implement year round fee system to assist with public use administration and infrastructure improvements.		X	X	X

Table 2: Comparison of Objectives and Strategies By Management Alternatives, Pilot Knob NWR

Goals, Objectives and Strategies	Alternative Themes	
	Current Management Direction	Expanded Species Protection and Opportunities for the Public
	Alt. 1	Alt. 2
	Applies to Alternative(s)	
Goal 1: Contribute to the recovery of federally listed species and the conservation of their subterranean habitat on the Refuge.		
Objective 1-1: Law Enforcement		
Activity: Presently, law enforcement activities are infrequent.	X	
Activity: Throughout the life of the plan, limit the amount of documented incidents of illegal activity to 1 incident per 60 hours of law enforcement effort.		X
Strategies:		
1. Define and upgrade existing access or acquire a new access to the Refuge.	X	X
2. Repair fencing and maintain boundary signs to help reduce illegal access.	X	X
3. Track law enforcement reports to detect trends in illegal activity at the Refuge.	X	X
4. Issue and monitor special use permits.	X	X
5. Develop a cooperative agreement with Missouri Department of Conservation to share law enforcement on the Refuge.		X
6. Initiate a Friends group or similar body to act as a "neighborhood watch" to assist in monitoring activity on the Refuge.		X
Objective 1-2: Bat Recovery		
Activity: Over the next 15 years, contribute to the stabilization or increase of Indiana Bat and Gray Bat numbers.	X	X
Strategies		
1. Work with MDC, MDNR, and other partners to implement State and Federal recovery plans for the Indiana Bat and Gray Bat.	X	X
2. Place barriers to restrict access to chasm leading to abandoned mine entrance.		X
3. Develop a survey protocol approved by the Indiana Bat Recovery Team for monitoring wintering bats within inaccessible hibernacula.		X
4. Investigate stabilizing the mine entrance to prevent its collapse.		X
Goal 2: Local residents and visitors are aware of the Refuge and its purpose.		
Objective 2-1: Public Access and Visitor Services		
Activity: Limit visits to those associated with research or education and requiring special use authorization.	X	
Activity: Within 5 years of plan approval, allow up to 100 visitors per year guided access to the Refuge.		X

Table 2: Comparison of Objectives and Strategies By Management Alternatives, Pilot Knob NWR

Goals, Objectives and Strategies	Alternative Themes	
	Current Management Direction	Expanded Species Protection and Opportunities for the Public
	Alt. 1	Alt. 2
	Applies to Alternative(s)	
Strategies		
1. Place barriers to restrict access to chasm leading to abandoned mine entrance.		X
2. Establish minimally developed administrative/maintenance access road passable by a four-wheel drive vehicle for implementing public use activities.	X	X
3. Accurately locate and map (using GPS and GIS technology) mine entrances and other potential hazards.		X
4. Develop a Refuge brochure.		X
5. Add .5 FTE Refuge Operations Specialist (5/7/9) to oversee biological monitoring, maintenance, cooperative agreements, interpretive programming, and outreach.		X
6. Explore partnership with Fort Davidson State Historic Site to assist with guided tours.		X
7. Explore seasonal closure of the Refuge to avoid disturbing hibernating bats.		X
8. Use appropriate methods to avoid hazards and provide for visitor safety.		X
9. Work with local residents to form a Friends group or some similar body to communicate information and support the Refuge.		X
10. Evaluate feasibility and compatibility of an observation platform on the summit of Pilot Knob.		X

Table 3: Comparison of Objectives and Strategies and By Management Alternative, Ozark Cavefish NWR

Goals, Objectives and Strategies	Alternative Themes	
	Current Management Direction	Expanded Species Protection and Opportunities for the Public
	Alt. 1	Alt. 2
	Applies to Alternative(s)	
Goal 1: Contribute to the recovery of federally listed species and the conservation of other subterranean species and their habitats within the Springfield Plateau.		
Objective 1-1: Habitat Management		
Activity: Presently, there is no active habitat management	X	
Activity: Within 10 years of plan approval, document historic conditions, collect current data on vegetation composition consistent with standards of the National Vegetation Classification System, and identify opportunities for habitat restoration.		X
Strategies:		
1. Develop a cooperative agreement with Missouri Department of Conservation to share management oversight of the Refuge.		X
2. Develop and begin implementation of a Habitat Management Plan.		X
3. Add .5 FTE Refuge Operations Specialist (5/7/9) to oversee Refuge management including habitat management, implementing recovery plans, building and maintaining partnerships, and managing visitor services.		X
Objective 1-2: Visitor Services and Public Awareness		
Activity: Presently, there is no active promotion of the Refuge other than a brochure and webpage.	X	
Activity: Within 10 years of plan approval, 33% of a randomly selected sample of residents within the Turnback Creek and Hearrell Spring recharge areas will recognize the purpose of the Refuge.		X
Strategies		
1. Maintain web cam at Hearrell Spring.	X	
2. Maintain WebCam at Hearrell Spring and provide interpretation.		X
3. Develop a cooperative agreement with Missouri Department of Conservation to share public use management and oversight of the Refuge.		X
4. Allow only scientific, educational, and interpretive uses at Hearrell Spring portion of Refuge.		X
5. Install educational/interpretive kiosks at Hearrell Spring and Turnback Creek portions of Refuge.		X
6. Offer compatible wildlife-dependent recreation at the Turnback Creek portion of the Refuge.		X
7. Develop a cooperative agreement with Neosho National Fish Hatchery to share management and oversight of the Hearrell Spring portion of the Refuge located in Neosho, Missouri near the hatchery.		X
Objective 1-3: Law Enforcement		

Table 3: Comparison of Objectives and Strategies and By Management Alternative, Ozark Cavefish NWR

Goals, Objectives and Strategies	Alternative Themes	
	Current Management Direction	Expanded Species Protection and Opportunities for the Public
	Alt. 1	Alt. 2
	Applies to Alternative(s)	
Activity: Presently, there are infrequent law enforcement inspections.	X	
Activity: Throughout the life of the plan, limit the amount of documented incidents of illegal activity to 1 incident per 60 hours of law enforcement effort.		X
Strategies		
1. Develop a cooperative agreement with Missouri Department of Conservation to share law enforcement oversight of the Refuge.		X
2. Post and maintain Refuge boundaries	X	X
Goal 2: Landowners in the recharge areas of the Refuge apply best management practices to maintain water quality.		
Objective 2-1: Recharge Area Conservation		
Activity: Presently there is no active program to improve water quality within the recharge areas for Turnback Creek or Hearrell Springs.	X	
Activity: At least 75 percent of landowners in the Turnback Creek recharge area will be presented with information regarding the relationship between best management practices and water quality and encouraged to apply the practices.		X
Strategies:		
1. Coordinate with Missouri Department of Conservation on Turnback Cave recharge area mapping.		X
2. Explore the need for mapping the recharge area of Hearrell Spring portion of Refuge.		X
3. Work with the Service's Partners for Wildlife program and the Missouri Department of Conservation's private lands programs to develop a landowner education program.		X
4. Work with Missouri Department of Conservation, Missouri Department of Natural Resources, Missouri Department of Transportation, landowners, and others to develop mitigation measures for hazardous materials spills.		X
5. Monitor water quality at various locations in the recharge area and communicate trends to landowners.		X

Chapter 3: Affected Environment

This chapter includes overview of the affected environments of Mingo, Pilot Knob and Ozark Cavefish national wildlife refuges. More detail is contained in Chapter 3 of the CCP itself.

3.1 Mingo National Wildlife Refuge

3.1.1 Introduction

Established in 1944 under authority of the Migratory Bird Treaty Act, the 21,592-acre Mingo National Wildlife Refuge covers portions of Stoddard and Wayne Counties in southeast Missouri, approximately 150 miles south of St. Louis. It contains 15,000 acres of bottomland hardwood forest, the largest remnant of the 2.5 million acres that once enveloped southeastern Missouri, and serves as a resting and wintering area for migratory waterfowl. Comprising the remainder of the Refuge are 5,000 acres of marsh and water, 1,300 acres of cropland and moist soil units, and 400 acres of grasslands.

Clearing of the region's bottomland hardwood forests for lumber and railroad ties began in the 1880s, and continued into the 1930s. Ultimately, legislation passed allowing the formation of drainage districts financed by long term bonds. In 1914 more than twenty existed in Stoddard County, including the Mingo Drainage District near Puxico. But the Mingo Drainage District struggled. Overflow from the St. Francis River thwarted permanent drainage, and soils proved less productive than those in other areas of the Bootheel. When land values plummeted during the Great Depression many drainage district land owners defaulted on tax payments rather than maintain unprofitable investments. The financially strapped Mingo Drainage District defaulted on bond payments and went bankrupt. Unregulated land uses followed until the U.S. Fish and Wildlife Service acquired the property in 1945. By that time the lands had been deforested, drained with an extensive system of ditches, burned by wildfires, and grazed indiscriminately by livestock.

Congress designated 7,730 acres in the western part of the Refuge as the Mingo Wilderness Area in 1976, formally protecting it under the provisions of the Wildness Act of1964. The act says that wilderness is, "…where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Wilderness policy permits hiking, backpacking, fishing, wildlife observation, and environmental education and interpretation. It generally prohibits motorized activities, although tools like chainsaws may be used in wildland fire management, after a MIST (Minimum Impact Suppression Tactics) analysis. Ditches and levees remain within the Mingo Wilderness Area, and help approximate water level fluctuations that once happened naturally.

There are seven Research Natural Areas on the Refuge; six are within the Mingo Wilderness Area. Each research natural area is part of a national network of reserved areas under various ownerships intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. No management activities occur within the Research Natural Areas, but they are affected by water level manipulations that occur across the Refuge.

3.1.2 Geographic/Ecosystem Setting

Mingo National Wildlife Refuge is located in Wayne and Stoddard Counties in the Bootheel region of southeast Missouri. Once an expansive swamp of bottomland hardwoods, the Bootheel was converted to agriculture during the last century and today is largely farmed for row crops. The Refuge is bordered to the west by the Missouri Ozarks and to the east by Crowley's Ridge, a prominent landform in the otherwise level Mississippi floodplain. Waters from the Refuge flow south to the St. Francis River via Mingo Creek and a series of drainage ditches.

Mingo National Wildlife Refuge is situated within the USFWS-designated Ozark Plateau Ecosystem. However, it is immediately adjacent to, and shares many common features with, the Lower Mississippi River Ecosystem, which once supported a vast bottomland hardwood forest complex that extended along the Mississippi River from Illinois to Louisiana. Today less than 20 percent of the bottomland hardwood forest remains and most is fragmented or in scattered patches throughout the region. Conservation and restoration of these forests is a top priority for the Service.

Mingo NWR contributes to the goals and objectives of various regional, national, and international

conservation plans and initiatives, including the North American Waterfowl Management Plan and Partners In Flight.

Other public conservation lands occur nearby. The 6,190-acre Duck Creek Conservation Area managed by the Missouri Department of Conservation adjoins the Refuge to the northeast. The Poplar Bluff Ranger District of the 1.5 million-acre Mark Twain National Forest lies several miles southwest of the Refuge. Wappapello Lake, a 210 acre reservoir along the St. Francis River, and much of the surrounding land is managed by the Army Corps of Engineers. Wappapello State Park administered by the Missouri Department of Natural Resources borders a portion of the reservoir.

3.1.3 Socioeconomic Setting

Mingo National Wildlife Refuge is located in Wayne and Stoddard counties, and is adjacent to Bollinger and Butler counties. Compared to the State of Missouri, this four-county area has a smaller population growth rate and is less racially and ethnically diverse. The area's population has a lower average income, and less high school and college education than the state's population as a whole.

The total population of the four counties was 95,861 in the 2000 Census. The population increased 6.9 percent during the 1990s while the State's population increased 9.3 percent. Wayne County grew the most at 14.9 percent, and Stoddard the least at 2.8 percent. The four-county population was 95.2 percent white in 2000; the State population was 84.9 percent white. In Missouri, 5.1 percent of the people five years and older speak a language other than English at home; in the four-county area it is 2.5 percent.

In 2000 there were a total of 47,522 full- and part-time jobs in the four-county area. Farm employment accounted for 8.0 percent of the jobs across the area. Bollinger County had the highest proportion of farm employment, 19.9 percent. Other sectors with sizable proportions of jobs are the services, retail, and manufacturing sectors.

Average per-capita income in the four-county area was $14,814 in 1999; in Missouri it was $19,936. The median household income in the four-county area was $27,114 in 1999; in the state it was $37,934.

In the four-county area, 9.9 percent of persons over 25 years of age hold a bachelor's degree or higher. The comparable figure in the state is 21.6 percent.

3.1.4 Climate

Long, hot summers and rather cool winters characterize the climate of the Refuge and surrounding area. An occasional cold wave brings near freezing or sub-freezing temperatures but seldom much snow. Precipitation is fairly heavy throughout the year, and prolonged droughts are rare. Summer precipitation falls mainly in afternoon thunderstorms.

In winter the average temperature is 37 degrees Fahrenheit, and the average daily minimum temperature is 28 degrees. In summer the average daily temperature is 78 degrees, and the average daily maximum temperature is 90 degrees. Total annual precipitation is 48 inches. Of this, about 25 inches, or 50 percent, usually falls in April through September. In two years out of ten, the rainfall in April through September is less than 20 inches. Thunderstorms occur on about 55 days each year, mostly in summer. The average annual snowfall is 11 inches. On average, nine days of the year have at least one inch of snow on the ground. The number of such days varies greatly from year to year.

3.1.5 Geology and Soils

As noted earlier, the Refuge lies in an abandoned channel of the Mississippi River known as the Advance Lowlands, bounded by the limestone bluffs of Crowley's Ridge to the south and east, and the Ozark Escarpment to the north and west. The St. Francis River flows from the Ozark Hills into the Advance Lowlands just south and west of the Refuge. When the Mississippi River shifted course, joining the Ohio River further north approximately 18,000 years ago an alluvial fan built up where the St. Francis River entered the lowlands. This alluvial fan acts as a natural levee, slowing drainage through the basin.

Several small sand ridges interrupt the otherwise level basin. The ridges, which vary in shape, may be ancient sand bars deposited by the Mississippi River or sand forced to the surface by earthquakes. The Refuge is in the heart of the New Madrid seismic zone, the source of some of the most powerful earthquakes in North America.

The most extensive soil type at Mingo NWR is Waverley Silt Loam, with a grayish brown silt loam surface layer and gray silt loam subsoil that is mottled throughout. A poorly drained acidic soil formed

under wet conditions and a high water table, it occupies approximately 50 to 60 percent of the Refuge. Falaya Silt Loam occupies a small part of the bottom in areas such as Stanley Creek and Lick Creek. It also borders the upland and the channel of Mingo Creek. Falaya soils have brown silt loam surface layers over grayish brown silt loam underlain at about 40 inches by fray silty clay loam. This soil is somewhat poorly drained, acidic, and subject to flooding or ponding. Organic soils occupy 800 to 900 hundred acres in Rockhouse and Monopoly marshes and consist of dark colored soils derived from organic matter. They were formed under wet marshy conditions in some of the lowest elevations.

The cherty soils of the steep slopes and stone outcropping along the west side of the Refuge are of the Doniphan series. Doniphan soils have light brown cherty silt loam surface layers and red clay subsoils. The ridgetops above Doniphan cherty silt loam are narrow and undulating and have about three feet of loess deposits. The soil is Union Silt Loam. The moderately well-drained Union soils have dark grayish brown silt loam surface horizons that are underlain by brown silty clay loam subsoils. They have fragipan layers at depths of 2.0 or 3.0 feet. On the moderate slopes of the uplands, especially along Highway 51 north of Puxico, there are deep, well-drained soils developed in thick lows. These soils are Loring Memphis Silt Loams and have brown silt loam surface layers and brown silt loam subsoils.

3.1.6 Water and Hydrology

The Refuge is within the lower portion of the St. Francis River basin, and acts as a reservoir during periods of flooding. Water enters from all directions until runoff is complete and water levels stabilize. Water flow within the Refuge is complex and varies depending on water depths within each of the pools. Poor drainage within the basin is slowed further by the dikes, levees, and ditches across the Refuge. Water exits the Refuge via a spillway along Mingo Creek, and flows south to the St. Francis River.

The St. Francis River flows 225 miles from Iron County in Missouri to the Arkansas/Missouri border, and another 207 miles through Arkansas until it joins with the Mississippi River. Hydrology of the St. Francis River and entire Bootheel region has been drastically altered. Extensive networks of ditches and levees drain the floodplain, and control seasonal flooding that once predominated.

3.1.7 Plant Communities

Refuge vegetation may be broadly divided into wetlands, comprised mainly of bottomland mixed hardwood forests, and upland forest. Figure 1 displays the principal plant communities at Mingo NWR.

Wetlands

With the exception of the bluffs on either side of the Refuge, most of the area is subject to seasonal flooding and is wet during at least a portion of each year (see Figure 1). Vegetation varies along a narrow elevational gradient that corresponds to duration of flooding. Four community types are delineated within the Refuge based on dominate species, elevation, and inundation.

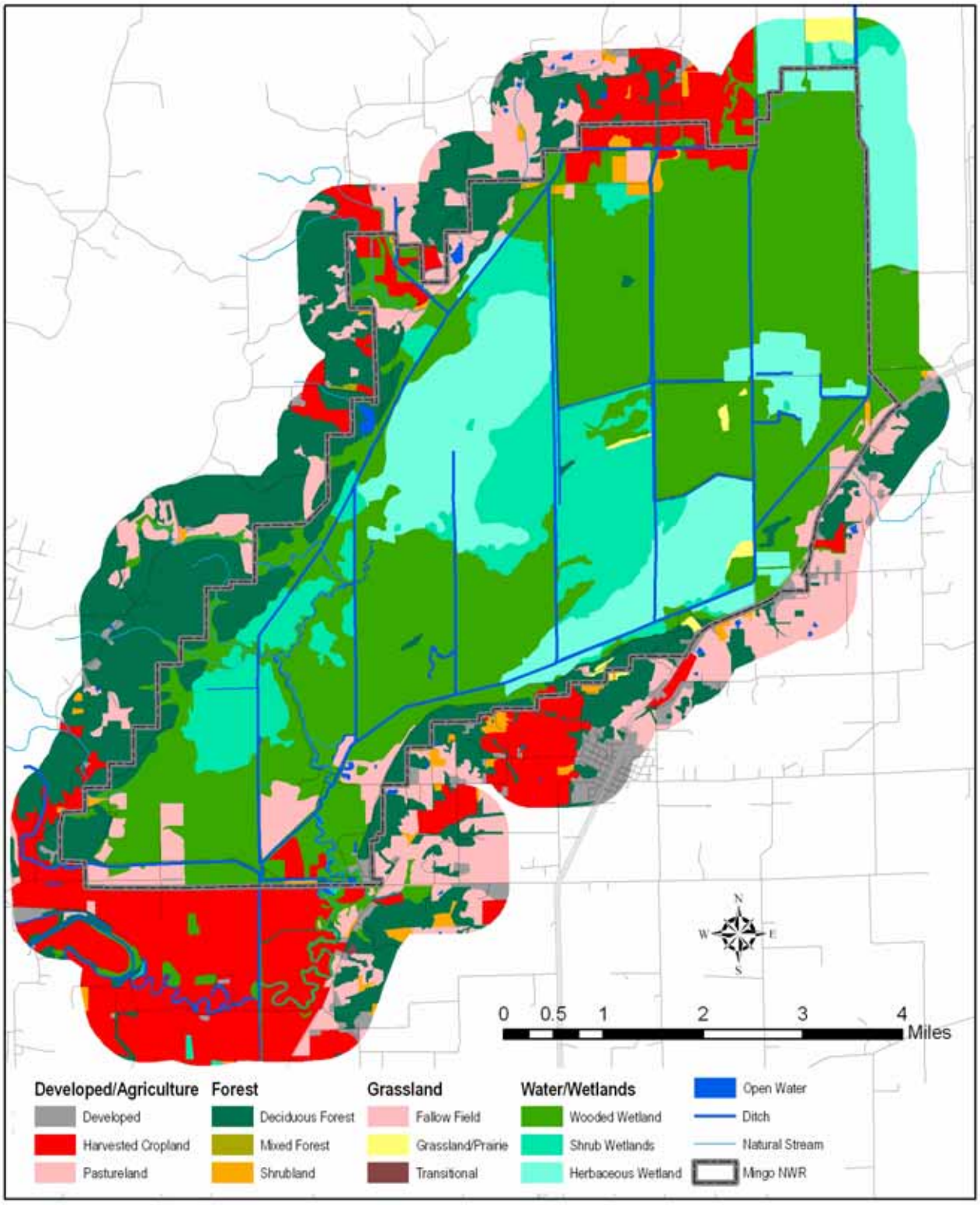
Terrace Bottoms Community – Terrace or second bottoms are located at the base of lower slopes, flat banks, and watercourse margins. These well-drained and rarely flooded transitional areas support a mixture of upland and flood plain woody species. Major trees are:

Sugar Maple (*Acer saccharum*)
Northern Red Oak (*Quercus rubra*)
Shagbark Hickory, Bitternut Hickory (*Carya cordiformis*)
Sweetgum (*Liquidambar styraciflua*)
American Elm (*Ulmus americana*)
Hackberry (*Celtis occidentalis*)
Box Elder (*Acer negundo*)
Chinkapin Oak, Blackgum (*Nyssa sylvatica*)
Black Walnut, Butternut (*Juglans cinerea*)
Black Cherry (*Prunus serotina*)
Bur Oak (*Quercus macrocarpa*)
Swamp Red Oak (*Quercus falcata*).

Oak Hardwood Bottoms Community – The most extensive bottomland forest type is the Oak Hardwood Bottoms. These Pin Oak flats occupy shallowly inundated areas along the banks between drainage ditch levees, and the low floodplains surrounding Rockhouse and Monopoly Marshes. Major trees are:

Pin Oak (*Quercus palustris*)
Willow Oak (*Quercus phellos*)
Overcup Oak (*Quercus lyrata*)
Green Ash (*Fraxinus pennsylvanica* var. *subintegerrima*)
Slippery Elm (*Ulmus rubra*)
American Elm, Red Maple (*Acer rubrum*)

Figure 1: Landcover, Mingo NWR



Sweetgum, Cherrybark Oak (*Quercus pagoda*)
Swamp Chestnut Oak (*Quercus michauxii*)
Swamp White Oak (*Quercus bicolor*)
Box Elder, Sugarberry (*Celtis laevigata*)
Persimmon (*Diospyros virginiana*)

Mixed Soft-Hardwood Levees Community – This community type exists along drainage ditch levees, stream margins, roadside embankments, and other watercourse borders. Tree species include:

Black Willow (*Salix nigra*)
Cottonwood (*Populus deltoides*)
Silver Maple (*Acer saccharinum*)
Sycamore (*Platanus occidentalis*)
River Birch (*Betula nigra*)

Later successsional species occurring in this community are similar to the Oak Hardwood Bottoms community.

Shallow Swamp Community – This community type occupies inundated areas such as Monopoly Marsh, Rockhouse Marsh, Mingo Creek, and Stanley Creek. The predominant species in these wooded swamps are:

Bald Cypress (*Taxodium distichum*)
Blackgum (*Nyssa biflora*), Swamp Cottonwood (*Populus hetrerophylla*)
Red Maple (*Acer rubrum)*, Pumpkin Ash (*Fraxinus tomentosa*)
Black Willow, Water Locust (*Gleditsia aquatica*)
Green Ash and Water Hickory (*Carya aquatica*)

Upland Forests

Oak-hickory forest type predominates on the cherty upland areas. Three community types are recognized.

Upland Old Fields Community – These areas include scattered woodland clearings, abandoned fields or pastures, and ridge roadsides which are reverting to an oak-hickory forest. Principal trees and shrubs are:

Sassafras (*Sassafras albidum*)
Persimmon (*Diospyros virginiana*)
Honey Locust (*Gleditsia triacanthos*)
Sumac (*Rhus spp.*)
Elm (*Ulmus spp.*)
Black Walnut (*Juglans nigra*)
Red Cedar (*Juniperus virginiana*)
Blackberry (*Rubus allegheniensis*)
Dewberry (*Rubus spp.*)
Coralberry (*Symphoricarpos orbiculatus*)
Multiflora Rose (*Rosa spp.*).

Xeric Ridge Crests Community – The driest and most exposed forest community exists on ridge crests, bluff tops, and upper slopes on thin, excessively drained soils. Over-story trees include:

Black Oak (*Quercus velutina*)
Post Oak (*Q. stellata*)
White Oak (*Q. alba*)
Black Hickory (*Carya texana*)
Mockernut Hickory (*C. tomentosa*)
Elm and White Ash (*Fraxinus americana*)

Understory trees and shrubs are:

Serviceberry (*Amelanchier spp.*)
Winged Elm (*Ulmus alata*)
Big Tree Plum (*Prunus mexicana*)
Sparkleberry (*Vaccinium arboreum*)
Hawthorn (*Crataegus spp.*)
Southern Blackhaw (*Viburnum spp.*)
Sumac (*Rhus spp.*)
Blueberry (*Vaccinium spp.*)
St. Andrew's Cross (*Ascyrum hypericoides*).

Mesic Slopes Community – Great species diversity occurs on the middle to lower slopes because of improved temperature-moisture conditions. Important trees and shrubs include:

White Oak, Mockernut Hickory, Shagbark Hickory (*Carya ovata*)
Chinkapin Oak (*Quercus muehlenbergii*)
White Ash, Sassafras, Flowering Dogwood (*Cornus florida*)
Mulberry (*Morus spp.*)
Pawpaw (*Asimina triloba*)
Bladdernut (*Staphylea trifolia*)
Spicebush (*Lindera spp.*)
Devil's Walking Stick (*Aralia spinosa*)
Wild Hydrangea (*Hydrangea arborescens*).

3.1.8 Fish and Wildlife

Birds – A total of 279 resident and migratory bird species use Refuge habitats throughout each year. Tens of thousands of Mallards, Canada Geese, and

other migrating waterfowl use Refuge wetlands as stopover or wintering habitat. Hooded Mergansers and Wood Ducks are resident breeders on the Refuge. Monopoly Marsh draws Wood Ducks from a five-state area during molting season. Bald Eagles, Least Bitterns, and Mourning Doves are among the 108 bird species that regularly breed on the Refuge. Appendix F contains a complete list of birds known to occur on the Refuge.

Mammals – Thirty-eight mammal species are found within the Refuge. White-tailed deer, a species popular for hunting and viewing, are abundant at a population density of 40 per square mile. There is a wide diversity of small mammals including three species of squirrels, two species of bats, and various mice, rats, and voles. The Refuge is one of the few places in Missouri where the swamp rabbit, a larger relative of the eastern cottontail rabbit, is known to occur. Unlike other rabbits, the swamp rabbit regularly takes to the water to move about and avoid predators. Appendix F contains a complete list of mammals found at Mingo NWR.

Amphibians and Reptiles – Amphibians and reptiles are abundant on the Refuge with more than 30 species of frogs, toads, salamanders, and snakes including the venomous western cottonmouth, southern copperhead, and timber rattlesnake. Many of these species hibernate within the cracks and crevices of the bluffs along the perimeter of the Refuge.

Fish – A complete list of fish species is not available. However, at least 15 species, including channel catfish, white crappie, spotted bass, and green sunfish, are known to occur in the ponds and ditches of the Refuge.

Threatened and Endangered Species – The Bald Eagle (*Haliaeetus leucocephalus*) occurs as a winter migrant and a summer breeder on Mingo NWR. The wintering Bald Eagle population can reach as high as 50 birds. Three active nesting territories existed in 2002 including one that has fledged 39 young over 17 years. The Bald Eagle is currently listed as a threatened species but is proposed for delisting.

3.1.9 Threats to Natural Resources

Six invasive species – non-native (or aggressive native) species of plants and animals that adversely affect native species of flora and fauna – are found on the Refuge. These include the nutria, Sericia lespedeza, Johnson grass, bull thistle, reed canary grass, and multiflora rose. These organizations are capable of out-competing and therefore displacing native plant and animal communities.

The toxic heavy metal mercury is present on the Refuge, but has not been measured in a consistent manner, so that exact levels are not known. Mercury is most problematic for animals when it has been "methylized," that is, converted through bacterial action to methylmercury, in which form it can both bioaccumulate and biomagnify. The recent issuing of a permit (now under appeal) to construct and operate a coal-burning power plant 85 miles east of Mingo NWR in Illinois has brought concerns about possible mercury deposition on the Refuge to the fore. The presence of the Mingo Wilderness Area, a Class I area in which higher air quality standards are supposed to be maintained, has accentuated this issue.

3.1.10 Archeological and Cultural Values

The Mingo National Wildlife Refuge Archeology District is listed on the National Register of Historic Places, one of seven such properties in Stoddard and Wayne counties.

Completed archeological surveys of the Refuge, including the Job Corps campus, have covered almost 7,200 acres. These surveys and other sources have identified 139 cultural resources sites on the Refuge. These sites represent all Midwest United States cultural periods from the earliest Paleo-Indian through 20th century Western, a period of about 12,000 years. Nevertheless, evidence shows no human presence in the Refuge and vicinity at the time Europeans first entered the region. One standing structure on the Refuge, the Patrol or Sweet cabin from the early 20th century, is considered eligible for the National Register.

The North American Consultation Database run by the Park Service to assist Federal agencies responding to the requirements of the Native American Graves and Protection and Repatriation Act lists no tribes with identified interests in Stoddard and Wayne counties. The database, however, is not a comprehensive list, being based on a limited number of legal sources. Cherokee, Choctaw, Creek, Delaware, Miami, Mingo (Iroquois), Osage, Quapaw, Seneca, and Shawnee may have had limited historic period interest in the Refuge area, the Chickasaw and Tunica may have had protohistoric period interest, and the antecedent Pawnee and Wichita may have had prehistoric interest. Other interest groups that might have a cultural resources concern about the Refuge have not yet been identified.

3.1.11 Refuge Recreation

Mingo NWR receives more than 100,000 visitors annually. The Wilderness Area, Red Mill Drive, and the Boardwalk are open year-round to visitors. The hunting area is closed to general public use from October 1 to March 15 and open the rest of the year. The canoe route is open year-round. Boating use is permitted throughout the Refuge except on Ditches 3, 4, 5 and Monopoly Marsh, which are closed from October 1 to March 1. The use of gasoline powered boat motors is prohibited. Electric motors are permitted outside the Wilderness Area but not within it. The moist soil units, Monopoly Marsh, and Rockhouse Marsh are closed to all entry from October 1 to March 14 during the period of peak waterfowl.

Hunting – A public hunting area is designated within the Refuge. Within this area archery deer and turkey hunting, spring firearm turkey hunting, and squirrel hunting are allowed concurrent with the State seasons. The Refuge is open for hunters from 1.5 hours before sunrise to 1.5 hours after sunset.

Squirrel hunting is permitted from late May through September 30, when the area is opened for archery deer and turkey hunting. Squirrel hunters may use a .22 rifle or a shotgun.

The archery deer and turkey season opens October 1 and runs through January. Bow hunters can harvest two deer during the archery season. During the firearms deer season in November hunters with a valid firearms deer permit can archery deer hunt on the Refuge. A muzzleloading firearms deer hunt is conducted in coordination with the Missouri Department of Conservation on a western portion of the Refuge. Hunters are selected through a lottery system for the hunt, which lasted for one weekend in 2001. In 2001, 1,214 people applied for the 135 available permits. A hunter was permitted to take one deer of either sex. During the hunt, the firearms hunt area is closed to other visitors, including anglers, auto tour route users, and canoe trail users.

A spring turkey hunt is allowed that runs approximately the last week of April through the first two weeks of May.

Waterfowl hunting is permitted concurrent with the state season in Pool 8, a 1,191-acre green tree reservoir. The unit is managed through a cooperative agreement with the Missouri Department of Conservation as a wade-in hunting area. Duck Creek Conservation Area conducts the duck hunt on a draw operation where hunters may choose a blind in the state area or the wade-in hunting area. Many hunters prefer to hunt the flooded timber in the wade-in area. Dogs are permitted for waterfowl hunting only and must be leashed or under voice command.

The Refuge and State cooperatively manage an area with five blinds that can be reached by an asphalt trail. These blinds are used to hunt squirrels with firearms and turkey and deer with bows. If hunters have the necessary permit from the State of Missouri, they can also hunt from a parked vehicle on pulloffs along Red Mill Drive. The Refuge has set aside a designated area for an accessible hunt during the muzzleloader deer season. Five temporary blinds are used during this hunt.

Fishing – The Refuge allows fishing concurrent with state seasons and regulations. All of the Refuge is open year-round except Ditches 3, 4, 5, the moist soil units, and Monopoly Marsh, which are closed from October 1 to March 1. The road between May Pond and Fox Pond, and the road between Ditches 2 and 3 are open to vehicular traffic access from May 15 to September 30. Fishing in the muzzleloader hunt area is closed during the weekend of the hunt.

Wildlife Observation and Photography – Although observation and photography occur throughout the Refuge, facilities that support these activities by bringing the visitor closer to wildlife include the auto tour route, five overlooks and three trails. The 19-mile Auto Tour Route is open during April, May, October, and November. The trails are open year-round. The primary attraction during the spring on the auto tour route is spring wildflowers. The attractions in the fall are the changing colors of foliage and migrating birds.

Interpretation – Interpretation facilities on the Refuge include the Visitor Center, exhibits along the auto tour, and three trails. The Visitor Center contains an audio-visual program, exhibits, dioramas, and displays on wildlife management, swamp ecology, archaeology, geology, and history. An auto tour brochure interprets points of interest, refuge management techniques, and wildlife habitat. The Boardwalk Nature Trail is constructed of a raised boardwalk traversing bottomland hardwoods and marsh. It is 0.8 mile long with a 0.2 mile spur leading to an overlook. An interpretive brochure, keyed to numbered spots, interprets the ecology of the area. The Hartz Pond Trail is a 0.2 mile loop that originates at the Visitor Center parking lot. The trail to Sweet's Cabin introduces visitors to the settlement heritage of the Refuge.

Environmental Education – The Refuge hosts Ecology Days for Stoddard and Butler Counties. Fifth grade students from seven schools in Stoddard County and fourth grade students in Butler County participate. Ecology Days reinforces what students learn about Missouri's natural resources in the classroom. The objective of the program is to prepare students for the Missouri Mastery Achievement Test, a statewide test administered in public schools.

Non-wildlife Dependent Recreation – The Refuge permits several forms of non-wildlife dependent recreation with certain restrictions. Horseback riding is allowed on the Refuge roads that are open to vehicular traffic sometime during the year. The route of the auto tour, for example, is open year-round to horseback riding, hiking, and biking. The canoe trail is open year round. Canoeists are primarily using the trail for bird watching and, to a lesser extent, for fishing. Berry, mushroom, pokeweed, and nut gathering occurs near the Rockhouse Overlook and along Bluff Drive. These activities are permitted outside the Wilderness Area as long as the ground is not disturbed.

3.2 Pilot Knob National Wildlife Refuge

3.2.1 Introduction

Pilot Knob National Wildlife Refuge, located on top of Pilot Knob Mountain in Iron County, Missouri, is managed by staff at Mingo National Wildlife Refuge. Acquired by donation from the Pilot Knob Ore Company on July 22, 1987 the 90-acre refuge contains iron mine shafts dating to the mid-1800s which are critical habitat for the Federally endangered Indiana bat. The abandoned shafts, excavated in rhyolite (a light-colored, igneous rock consisting primarily of the mineral silica), are well-ventilated by upper and lower entrances. The mine traps cold air and provides ideal conditions for hibernating bats, which enter the shafts in the fall and exit in the spring. Up to a half of Missouri's known population of Indiana bats is believed to hibernate in the old mine.

The Refuge was created expressly to protect the Indiana bat; there is no other management emphasis. Public use is prohibited at this time.

3.2.2 Geographic/Ecosystem Setting

Pilot Knob National Wildlife Refuge is located in southeast Missouri in Iron County. It consists of a steep conical hill, ascending more than 560 feet above the Arcadia Valley floor.

Like Mingo NWR, Pilot Knob NWR is situated near the boundary of the Ozark Plateau Ecosystem and the Lower Mississippi River Ecosystem. See the description of these in Chapter 1 and in Chapter 3 under Mingo NWR, respectively. However, Pilot Knob Refuge is also very close to the Lower Missouri River Ecosystem.

The Lower Missouri River Ecosystem is associated with the lower reaches of the Missouri River. The "Big Muddy" has changed drastically in the two centuries since Lewis and Clark first explored it. Then it was a diverse system of floodplains, braided channels, riparian lands, chutes, sloughs, islands, sandbars, and backwaters (USFWS, no date-c). The Missouri continuously reshaped its channel and floodplain, resulting in a complex natural system supporting an incredible diversity of fish, wildlife, and plants. The desire to tame the Big Muddy's floods and develop the river for navigation led to intense channelization and reservoir construction beginning in the first half of the 20th century. Six major dams and other projects eventually converted the Missouri into a series of reservoirs and channelized waterways, effectively severing the river from its floodplain.

3.2.3 Socioeconomic Setting

Pilot Knob National Wildlife Refuge is located in rural Iron County, Missouri. Iron County lost population between 2000 and 2003, in contrast to the State of Missouri, which grew by about two percent; the county is also less racially and ethnically diverse than the state. Its population has a lower average income, and less high school and college education than the state's population as a whole.

The 2003 population estimate for Iron County was 10,306, which was a 3.7 percent decline from the population in 2000 (Census, 2005a). This population decline perpetuated and accelerated a 0.3 percent decline in the county's population from 1990 to 2000. Iron County's rural character is shown by its population density in 2000 of 19 persons per square mile; Missouri's was 81 per square mile in the same year. The county's population is less diverse than Missouri's. Iron County was 97 percent white in 2000, compared with Missouri as a whole which was 85 percent white. In Missouri, five percent of the people five years and older speak a language other than

English at home; in Iron County the corresponding figure is 2 percent. Less than 1 percent of the population was foreign-born.

Private non-farm employment numbered 2,116 in 2001. Mean travel time to work was slightly higher than the state mean. The unemployment rate of 9-10 percent is almost double the national average of about 5 percent (BLS, 2005). Median household income in 1999 was $26,080, 30 percent lower than the $37,934 median for Missouri as a whole. The 1999 poverty rate of 19 percent for the county was substantially higher than the statewide average of 12 percent, although this higher rate is typical for rural counties.

As with most rural counties, educational attainment in Iron County is lower than the state and nation. In 2000, 65 percent of Iron County residents 25 or older had a high school diploma, compared with 81 percent for the state as a whole and 80 percent for the entire United States. With regard to higher education, eight percent of Iron County residents 25 or older had earned a Bachelor's degree or higher, in comparison with 22 percent of state residents 25 or older as a whole and 24 percent of all Americans.

3.2.4 Climate

The climate of the Refuge is humid and continental with warm summers and cool winters. Mean annual temperature of Iron County is 56 degrees Fahrenheit (F) with a mean January temperature of 32 degrees F and a mean July temperature of 73 degrees F. Mean annual precipitation is 44.3 inches and is rather evenly distributed throughout the year with an average of 3.7 inches per month. Mean length of the growing season in Iron County is 185 days with the average first freeze date occurring October 11 and the average last freeze date occurring April 27.

3.2.5 Geology and Soils

Pilot Knob diverges from the general igneous hills in many aspects. It is cone-shaped and largely separated from the adjoining porphyry hills, connected on the east by a low neck of igneous rock which emerges only about 200 feet above the surrounding Cambrian rocks. It has a basal diameter of three quarters of a mile and rises about 600 feet above the surrounding valley, attaining an elevation of approximately 1,500 feet above sea level. To the north, across a narrow valley is Buzzard Mountain, on the northwest is Cedar Hill, on the southwest is Shepherd Mountain, and on the east and southeast are other mountains all of which are composed of compact, reddish brown porphyry (igneous rock) which does not differ essentially from that constituting the lower portion of Pilot Knob.

The majority of Pilot Knob mountain soils are comprised of Killarney very cobbly silt loam, 14 to 50 percent slopes, and rubbly. This is a well-drained soil with a dark grayish brown very cobbly silt loam about three inches thick. The subsurface soil is a very brown cobbly silt loam about four inches thick. The upper 29 inches of the subsoil is yellowish brown very cobbly silt loam, and very gravelly silty clay loam. The surface runoff is high and erosion is a major hazard. The Killarney soil type covers approximately 50-60 percent of the mountain's base.

The second soil type is Irondale very cobbly silt loam, 15 to 40 percent slopes, and rubbly. Stones and Boulders generally cover 15 to 50 percent of the surface. The surface layer is extremely dark grayish brown very cobbly silt loam about 3 inches thick. The subsurface layer is a brown very cobbly silt loam about five inches thick. The subsoil is very cobbly silt loam about 32 inches thick. It is yellowish brown in the upper part and reddish brown in the lower part. Rhyolite bedrock is at a depth of about 35 inches. Permeability is moderate, but surface runoff is rapid. The organic content is low, and the surface layer is friable but cannot be easily tilled because it commonly has 50 percent or more rock fragments.

3.2.6 Water and Hydrology

As indicated above, annual mean precipitation at Pilot Knob is about 44 inches, more or less evenly distributed throughout the year, and falling as rain.

3.2.7 Plant Communities

Upland forest covers the Refuge. Oak-hickory forest types predominate on the cobbly silt loam areas, and are interspersed with shortleaf pine in places. These shallow soils support various forbs and native grasses, such as sumac (*Rhus* spp.), coralberry (*Symphoricarpos orbiculatus*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and indiangrass (*Sorghastrum nutans*).

While grasses do grow beneath the upland forests mentioned just above, there are no grasslands or prairies proper (devoid of tree cover or a canopy) on the Refuge.

3.2.8 Fish and Wildlife Communities

Birds – Due to the newness of the Refuge, its inaccessibility and the lack of visitation, as well as to its small size and limited range of habitats, it supports fewer birds and less avian diversity than a typical national wildlife refuge. To date, 32 species of birds have been documented on the Refuge. The Refuge's bird list is shown in Chapter 3 of the CCP.

Mammals – Eighteen species of mammals have been documented at Pilot Knob or are expected to occur there. The Refuge's mammal list is shown in Chapter 3 of the CCP.

Reptiles and Amphibians – At least 14 species of reptiles and amphibians have been documented at Pilot Knob, including snakes, salamanders, turtles, skinks, toads, frogs and treefrogs. The Refuge's list of reptiles and amphibians is shown in Chapter 3 of the CCP.

Fish – The occurrence of fish on the Refuge is unlikely due to its location on the top and upper slopes of a hill or knob.

Threatened and Endangered Species – The Federally endangered Indiana bat hibernates within the abandoned mine shaft located at the peak of Pilot Knob Mountain. There are differing estimates of Pilot Knob's Indiana bat population, but the number is likely within the range of 50,000 to 100,000. The bats generally arrive in September and leave in April.

The gray bat also hibernates in the mine, and is listed as a federal endangered species. Fall migration begins in early September and generally completes by early November.

Since its placement on the endangered species list in 1976, the gray bat has become of particular concern. Its population decline is believed to be due to mainly human disturbances. These disturbances include vandalism, excessive pesticide use, overall insect prey decline due to pollution, and cave commercialization. The decline in gray bat populations can also be attributed to natural catastrophes. Collapsing caves and flooding have been known to render many gray bats homeless.

3.2.9 Threats to Resources

There are no invasive species known to occur on Pilot Knob NWR. Contaminants have not been studied or documented on the Refuge, but may expected to occur in at least low concentrations, as they do in virtually all locations. Whether or not these concentrations, whatever they are, actually pose a threat to wildlife and listed species at Pilot Knob is yet to be determined.

3.2.10 Archeological and Cultural Values

No archeological investigations have been conducted at Pilot Knob NWR. The iron mine probably is not eligible for the National Register of Historic Places. No other cultural resources have been identified on the Refuge.

Cultural resources are important parts of the Nation's heritage. The Service is committed to protecting valuable evidence of human interactions with each other and the landscape. Protection is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

3.2.11 Refuge Recreation

The Refuge is not open to the public, and no visitor services are provided. No hunting, fishing, wildlife observation and photography, or environmental education and interpretation take place on Pilot Knob NWR. Neither is any non-wildlife dependent recreation permitted at present.

3.3 Ozark Cavefish National Wildlife Refuge

3.3.1 Introduction

The 40-acre Ozark Cavefish National Wildlife Refuge, located twenty miles west of Springfield in Lawrence County, Missouri, was acquired in 1991 to protect a Federally endangered species, the Ozark cavefish. Turnback Creek Cave Spring is located on this property and is the outlet of an underground stream known to contain a population of the endangered Ozark cavefish. Access to the stream is gained via Turnback cave, which has openings on adjacent property owned by the Missouri Department of Conservation. The Refuge is managed by staff at Mingo National Wildlife Refuge, in Puxico, MO, some 200 miles to the east.

3.3.2 Geographic/Ecosystem Setting

Ozark Cavefish National Wildlife Refuge is within the U.S. Fish and Wildlife Service's designated Arkansas/Red Rivers Ecosystem. The Arkansas/Red Rivers Ecosystem covers approximately 245,000 square miles, extends from the Rocky Mountains of Colorado to the bayous of Louisiana, and includes all of Oklahoma and parts of seven

other States. This large area encompasses a vast array of land forms, soil types, rainfall levels, and elevations. The resulting range of habitats allows the Arkansas/Red Rivers ecosystem to support one of the most diverse collections of fish and wildlife resources in the nation. The most critical resource issues in the Arkansas/Red Rivers ecosystem center on management of water quality and quantity.

3.3.3 Socioeconomic Setting

Ozark Cavefish NWR is located in Lawrence County, Missouri. This county is primarily agricultural, its principal products including wheat, hay, oats, barley, corn, apples, peaches, and vegetables. Farmers also raise turkeys and cattle and there is a dairy industry. Manufacturing, primarily dairy and grain products, occurs in the towns of Aurora, Mt. Vernon, Pierce City, and Marionville.

The 2003 population estimate for Lawrence County was 36,426, which was a 3.5 percent increase from the population in 2000 (Census, 2005b), nearly double the rate of population growth in Missouri as a whole (1.9 percent from 2000 to 2003). This population growth continued a trend from the 1990s, during which the county's population grew by 16.4 percent, in comparison to 9.3 percent for the state. Lawrence County's population density in 2000 was 57 persons per square mile, a little less Missouri's density of 81 per square mile in the same year. The county's population is less diverse than that of Missouri as a whole. Lawrence County was 96 percent white in 2000, compared with Missouri as a whole, which was 85 percent white. Blacks comprised 0.3 percent of the county population versus 11 percent in the entire state and Asians 0.2 percent compared to the 1.1 percent in the entire state. However, both American Indians and Hispanics are represented in greater proportions in the county population than in the state's population. Hispanics compose 3.4 percent of the Lawrence County population compared to 2.1 percent of Missouri's population, while American Indians make up 0.8 percent of the county and 0.4 percent of the state. Approximately 2 percent of the county population was foreign-born, about the same percentage as the state-wide population of foreign-born persons(Census, 2005b).

Private non-farm employment in Lawrence County numbered about 7,000 in 2001. Mean travel time to work was almost identical to the state mean, 23.6 versus 23.8 minutes. The county unemployment rate of 4-5 percent percent is very close to the national average (BLS, 2005). Median household income in 1999 was $31,239, 18 percent lower than the $37,934 median for Missouri as a whole. The 1999 poverty rate of 14 percent for the county was slightly higher than the statewide average of 12 percent, although this higher rate is typical for rural counties (Census, 2005b).

Average educational attainment in Lawrence County is slightly lower than the state and nation. In 2000, 77 percent of county residents 25 or older had a high school diploma, compared with 81 percent for the state as a whole and 80 percent for the entire U.S. With regard to higher education, 12 percent of Lawrence County residents 25 or older had earned a Bachelor's degree or higher, in comparison with 22 percent of state residents 25 or older as a whole and 24 percent of all Americans.

3.3.4 Climate

The climate of Lawrence County is humid continental with warm summers and cool winters. Mean annual temperature of Lawrence County is 55.9 Fahrenheit with a mean January temperature of 32.6 F and a mean July temperature of 77.7 F. Rainfall is fairly heavy with mean annual precipitation of 39.74 inches and is rather evenly distributed throughout the year with an average of 3.3 inches per month. Mean length of the growing season in Lawrence County is 189 days with the average first freeze date occurring October 14 and the average last freeze date occurring April 28.

3.3.5 Geology and Soils

Wilderness cherty silt loam, the primary soil type found on the Refuge, has 2 to 9 percent slopes. It is deep, gently or moderately sloping, and moderately well drained. Some areas have small and large sinkholes. Coarse fragments of chert are on the surface. Generally, the surface layer is dark grayish brown cherty silt loam about 2 inches thick. The subsurface layer is brown cherty silt loam about 8 inches thick. The subsoil above the fragipan is about 11 inches thick, with the upper part being a yellowish brown, friable cherty silt loam, and the lower part a brown, firm cherty silty clay loam. The fragipan is about 35 inches thick. The upper part is pale brown, firm, cherty silt loam, and the lower part is mottled, multicolored, firm very cherty silty clay loam. The subsoil below the fragipan is dark red, very firm cherty clay to a depth of 72 inches. Some areas are stony. This soil is moderately permeable and surface runoff is medium.

3.3.6 Water and Hydrology

Turnback Cave is developed in Mississippian Burlington-Keokuk Limestone on the west side of Turnback Creek in Lawrence County. It is an extensive cave containing over 3,000 feet of interconnecting passages. The stream passage is a few hundred feet from the main entrance and trends roughly north. Water enters the stream passage at the southern end, and exits the cave through a spring along Turnback Creek to the north. Turnback Creek originates in northwestern Christian County about 12 miles southeast of Turnback Cave.

3.3.7 Plant Communities

Wetlands

Terrace Bottoms Community – Terrace or second bottoms are located at the base of lower slopes, flat banks, and watercourse margins. These well-drained and rarely flooded transitional areas support a mixture of upland and flood plain woody species. Major trees are:

Sugar Maple (*Acer saccharum*)
Northern Red Oak (*Quercus rubra*)
Shagbark Hickory (*Carya ouata*), Bitternut Hickory (*Carya cordiformis*)
Sweetgum (*Liquidambar styraciflua*)
American Elm (*Ulmus americana*)
Hackberry (*Celtis occidentalis*)
Box Elder (*Acer negundo*)
Chinkapin Oak (*Q. muehlenbergii*)
Blackgum (*Nyssa sylvatica*)
Black Walnut (*Juglans nigra*)
Butternut (*Juglans cinerea*)
Black Cherry (*Prunus serotina*)
Bur Oak (*Q. macrocarpa*)
Swamp Red Oak (*Q. falcata*)

Mixed Soft-Hardwood Levees Community – This community type exists along drainage ditch levees, stream margins, roadside embankments, and other watercourse borders. Tree species include:

Black Willow (*Salix nigra*)
Cottonwood (*Populus deltoides*)
Silver Maple (*Acer saccharinum*)
Sycamore (*Platanus occidentalis*)
River Birch (*Betula nigra*)

Later successional species occurring in this community are similar to the Oak Hardwood Bottoms community.

Forests

Upland Old Fields Community – These areas include scattered woodland clearings, abandoned fields or pastures, and ridge roadsides which are reverting to an oak-hickory forest. Principal trees and shrubs are:

Sassafras (*Sassafras albidum*)
Persimmon (*Diospyros virginiana*)
Honey Locust (*Gleditsia triacanthos*)
Sumac (*Rhus spp.*)
Elm (*Ulmus spp.*)
Black Walnut (*Juglans nigra*), Red Cedar (*Juniperus virginiana*)
Blackberry (*Rubus allegheniensis*)
Dewberry (*Rubus spp.*)
Coralberry (*Symphoricarpos orbiculatus*)
Multiflora Rose (*Rosa spp.*)

Xeric Ridge Crests Community – The driest and most exposed forest community exists on ridge crests, bluff tops, and upper slopes on thin, excessively drained soils. Over-story trees include:

Black Oak (*Quercus velutina*)
Post Oak (*Q. stellata*)
White Oak (*Q. alba*)
Black Hickory (*Carya texana*)
Mockernut Hickory (*C. tomentosa*)
Elm (*Ulmus* spp.) and White Ash (*Fraxinus americana*)

Understory trees and shrubs are:

Serviceberry (*Amelanchier spp.*)
Winged Elm (*Ulmus alata*)
Big Tree Plum (*Prunus mexicana*)
Sparkleberry (*Vaccinium arboreum*)
Hawthorn (*Crataegus spp.*)
Southern Blackhaw (*Viburnum spp.*)
Sumac, Blueberry (*Vaccinium spp.*)
St. Andrew's Cross (*Ascyrum hypericoides*).

Mesic Slopes Community – Great species diversity occurs on the middle to lower slopes because of improved temperature-moisture conditions. Important trees and shrubs include:

- White Oak (*Quercus alba*), Mockernut Hickory (*Carya alba*) Shagbark Hickory (*Carya ovata*)
- Chinkapin Oak (*Quercus muehlenbergii*)
- White Ash (*Fraxinus americana*), Sassafras (*Sassafras albidum*), Flowering Dogwood (*Cornus florida*)
- Mulberry (*Morus spp.*)
- Pawpaw (*Asimina triloba*)
- Bladdernut (*Staphylea trifolia*)
- Spicebush (*Lindera spp.*)
- Devil's Walking Stick (*Aralia spinosa*)
- Wild Hydrangea (*Hydrangea arborescens*).

3.3.8 Fish and Wildlife Communities

Birds – The Service has no information on the species of birds that may be present on the Refuge, that is, the Refuge has no bird list. However, a number of birds nest or migrate through the area and these may be expected to occur at least seasonally on Ozark Cavefish NWR.

Mammals – At this time, the Refuge does not have a mammal list, though a number of species that are found in this part of Missouri would be expected to occur at Ozark Cavefish NWR.

Amphibians and Reptiles – At this time, the Refuge does not have a list of amphibians and reptiles, though a number of species would be expected to occur at Ozark Cavefish NWR.

Fish – At this time, the Refuge does not have a list documenting which species of fish are present.

Invertebrates – At this time, the Refuge does not have a list of invertebrates whose presence on the Refuge has been documented.

Threatened and Endangered Species – There are two listed endangered, threatened, or rare species that occur on Ozark Cavefish NWR.

A population of federally threatened Ozark cavefish (*Amblyopsis rosae*) inhabits Turnback Creek Cave Spring within the Ozark Cavefish NWR. The Ozark cavefish was listed as threatened in 1984. A colorless fish about 2.25 inches long, its head is flattened, and it has a slightly protruding lower jaw. The fish has no pelvic fin and its dorsal and anal fins are farther back than on most fish. The Ozark cavefish has only rudimentary or vestigal eyes and no optic nerve. However, it is well-adapted to dark environment of caves through well-developed sensory papillae. The reproductive rate of Ozark cavefish is comparatively low (USFWS, 1992).

The Ozark cavefish lives its entire life in cave streams, underground waters, and springs. It uses sense organs located on the sides of its head, body, and tail to find food. Its range is restricted to caves in Missouri, Arkansas, and Oklahoma; as of 1992, 15 caves had verified populations. Ozark cavefish rely heavily on microscopic organisms like plankton as a food source, but also feed on small crustaceans, salamander larvae, and bat guano.

Factors that have led to the decline of the Ozark cavefish include habitat destruction, collecting of specimens, and disturbance by spelunkers (cavers). In terms of its recovery, protection of caves containing cavefish is the most important task. This includes monitoring the quality of water flowing into these caves, and erecting fences or gates that limit access by humans, but that do not interfere with bat populations. In many caves, the principal source of energy for the organisms on which cavefish feed is bat guano. Therefore, Ozark cavefish survival depends on the survival of bats.

The federally endangered gray bat utilizes Turnback Cave in the summer for reproductive and rearing purposes. As mentioned above, guano produced by the bats provides an important food source for Ozark cavefish.

3.3.9 Threats to Resources

No invasive species are known to occur on Ozark Cavefish NWR. The situation with regard to contaminants on the Refuge is unknown. If water were to become polluted for whatever reason upstream in the recharge areas of Turnback Creek or Hearrell Springs, this would constitute a threat to the resources in the Refuge, but this is a hypothetical threat at this point.

3.3.10 Archeological and Cultural Values

No archeological investigations have occurred at Ozark Cavefish NWR, and no cultural resources have been identified on the Refuge.

Cultural resources are important parts of the Nation's heritage. The Service is committed to protecting valuable evidence of human interactions with each other and the landscape. Protection is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

3.3.11 Refuge Recreation

The Refuge is not open to the public, and no visitor services are provided. No hunting, fishing, wild-

life observation and photography, or environmental education and interpretation take place at Ozark Cavefish NWR. Neither is any non-wildlife dependent recreation permitted at present.

Chapter 4: Environmental Consequences

4.1 Effects Common to All Alternatives at All Refuges

Specific environmental and social impacts of implementing each alternative are examined for each of the 10 resources. Several potential effects will be very similar under each alternative and are summarized below.

4.1.1 Air Quality

Air quality in most of Missouri is generally moderate. The only counties in the state that are in nonattainment for two of the National Ambient Air Quality Standards (NAAQS) – ground-level ozone and fine particle pollution – are five counties in the St. Louis area. The counties in which Mingo, Pilot Knob and Ozark Cavefish refuges are located are each in attainment for all of the NAAQS. However, the Mingo Wilderness Area is a Class I air quality area, which means it must meet higher air quality standards, especially with regard to avoiding visibility impairment.

Ozone (O3), a primary chemical constituent of smog, forms when volatile organic compounds (VOCs) and oxides of nitrogen (NOx) react in the presence of sunlight. Elevated ozone levels produce distinctive stippling and chlorosis in sensitive plant species. Observations by trained observers in the field can be used to identify ozone injury. The USFWS has conducted studies in a number of Class I areas on national wildlife refuges to evaluate vegetation for symptoms of ozone injury. Ozone injury has been documented at most of the Class I USFWS areas surveyed, including Mingo NWR (Porter, 2000).

Peabody Energy has proposed the construction of a coal-burning power plant in Illinois upwind of Mingo NWR. Based on air modeling analysis by the Service, the Refuge has raised concerns about the plant's potential air quality impacts on the Refuge and particularly the Mingo Wilderness Area.

None of the management alternatives at Mingo, Pilot Knob or Ozark Cavefish NWR's would have appreciable, long-term impacts on air quality. At Mingo NWR, habitat management involving prescribed fire would occur under each alternative, but only under ideal weather conditions. Approved smoke management practices developed by state and federal land management agencies would be implemented in all burning events. In addition, the generally low population density of the farmlands and wildlands bordering the Refuge (including Duck Creek WMA) would serve to minimize even temporary smoke-related, air quality impacts by reducing the number of potential "sensitive receptors" that could be affected by excessive smoke. Tailpipe emissions from operation of Refuge equipment and from visitation to the refuge by the motoring public are negligible in comparison with overall regional emissions.

4.1.2 Environmental Justice

Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" was signed by President Clinton on February 11, 1994. Its purpose was to focus the attention of federal agencies on the environmental and human health conditions of minority and low-income populations with the goal of achieving environmental protection for all communities. The Order directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The Order is also intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low-income communities access to public information and participation in matters relating to human health or the environment.

None of the management alternatives for the three Refuges described in this EA will disproportionately place any adverse environmental, economic, social, or health impacts on minority and low-income populations. The percentage of minorities in the three counties in which the three refuges are located is lower than in Missouri (and much lower than the United States) as a whole. Average incomes and poverty rates within these counties are comparable to other rural counties in the state. Public use activities that would be offered under each of the alternatives at each of the three refuges would be available to any visitor regardless of race, ethnicity or income level.

4.1.3 Climate Change Impacts

The U.S. Department of the Interior issued an order in January 2001 requiring federal agencies, under its direction, that have land management responsibilities to consider potential climate change impacts as part of long range planning endeavors. The increase of carbon dioxide (CO2) within the earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact to be considered in planning. The U.S. Department of Energy's "Carbon Sequestration Research and Development" (U.S. DOE, 1999) defines carbon sequestration as "...the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts –grasslands, forests, wetlands, tundra, and desert – are effective both in preventing carbon emission and acting as a biological "scrubber" of atmospheric CO2. The Department of Energy report's conclusions noted that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere. One Mingo NWR activity in particular – prescribed burning – releases CO2 directly to the atmosphere from the biomass consumed during combustion. However, there is actually no net loss of carbon, since new vegetation quickly germinates and sprouts to replace the burned-up biomass and sequesters or assimilates an approximately equal amount of carbon as was lost to the air. Overall, there should be little or no net change in the amount of carbon sequestered at Mingo NWR, Pilot Knob NWR, or Ozark Cavefish NWR from any of the proposed management alternatives.

Preserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges. The actions proposed in this CCP would preserve or restore land and habitat, and would thus retain existing carbon sequestration on the three refuges. This in turn contributes positively to efforts to mitigate human-induced global climate change.

4.1.4 Other Common Effects

None of the alternatives at any of the three Refuges would have more than negligible or at most minor effects on soils, topography, noise levels, land use patterns in and around the refuges, transportation and traffic, waste management, human health and safety, or visual resources.

4.2 Mingo National Wildlife Refuge

4.2.1 Effects Common to All Alternatives at Mingo NWR

Water Quality

Except for high sediment loads and turbidity, water quality in Refuge water bodies such as the pools, ponds, streams, and drainage ditches is generally good. Proposed Refuge management activities such as prescribed fire, mowing, ditch cleaning, and approved herbicide use to control invasive and weedy plant species, should not negatively affect water quality. The same conclusion applies to present and proposed visitor use, including such activities as walking the nature trails, driving the auto tour route, hunting, fishing, photography, nature observation, and interpretation.

Economic Benefits

Under each alternative, Mingo NWR would generate comparable economic benefits to surrounding communities. Spending associated with wildlife observation, hunting, and fishing generates a substantial amount of economic activity across the United States, and Mingo NWR is no exception. Visitors to Mingo NWR spend money on a wide variety of goods and services, including food, lodging, transportation, outdoor apparel, binoculars, cameras, film, ammunition, and fishing tackle. This direct spending in turn generates economic activity – increased output, jobs, income, and tax revenue – throughout the local and regional economy.

To these economic benefits can be added two others:

Mingo NWR's annual payroll to approximately 10 employees, which generates additional economic activity from purchases in the local and regional economy
Refuge purchases of materials, equipment, and services from local suppliers.

These benefits are not expected to vary substantially between alternatives.

4.2.2 Summary of Effects by Resource and Alternative for Mingo NWR

Key analysis factors are defined as habitat requirements or limiting factors important to each

of the ten resources analyzed. The analysis focuses on the effects of each alternative on these factors. Table 5 on page 174 summarizes the impacts for each alternative on each of the 10 resources analyzed.

4.2.2.1 Migratory Birds

More than 250 species of migratory birds use Mingo NWR as feeding or breeding habitat. Environmental consequences for these species are discussed in four categories: waterfowl, shorebirds, marsh and wading birds, and landbirds.

4.2.2.2 Waterfowl

Key analysis factors are:

- # hard mast, moist soil plants, invertebrates
- # loafing areas free of disturbance with adequate cover and proper water depth
- # isolated courtship areas partitioned by bottomland trees
- # streams, ephemeral wetlands, and tree cavities
- # open water interspersed with vegetation

Mingo NWR is used by spring migrating waterfowl for feeding and courtship. Moist soil units provide seeds, rhizomes, and tubers – foods with high energy content – as well as invertebrates. Vertical structure of the bottomland forest, largely related to tree density and diameter, creates isolated areas favorable for waterfowl courtship behavior. Hard mast production of bottomland forests also provides food for waterfowl during fall migration. Migrating waterfowl require loafing habitat, areas largely free of disturbance with adequate hiding cover and water depth. Breeding waterfowl, mostly Wood Ducks and Hooded Mergansers, require spring ephemeral wetlands, wooded streams, and nesting cavities. Breeding activity begins in mid-January with courtship displays and lasts through August when molting Wood Ducks and their young congregate in Monopoly Marsh. Brood habitat for these species requires an interspersion of open water and vegetation within shallow water wetlands.

Alternative 1

Migratory waterfowl are expected to continue using the Refuge at present levels over the life of the plan barring changes in waterfowl numbers or migration patterns influenced by conditions beyond the Refuge. The amount and distribution of habitats would remain the same including 15,000 acres of bottomland forest used as brood and wintering habitat by Wood Ducks, 3,300 acres of open marsh, and 704 acres of moist soil management that provide herbaceous foods and invertebrates to meet the nutritional needs of migrating waterbirds. Drainage improvements along a 10-mile portion of the ditch network would decrease, but not eliminate, prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades. Prolonged flooding also shifts forest composition by favoring flood tolerant tree species. Years of prolonged flooding at Mingo NWR have favored overcup oak and red maple on sites formerly occupied by other oak species that produce smaller acorns more easily eaten by waterfowl.

Under Alternative 1, drainage along much of the ditch system would not be improved by removal of sediments, and some portions of the bottomland forest may continue to die and not be replaced or become dominated by species with greater flood tolerances or that produce hard mast too large to be readily eaten by waterfowl. In the long term this would produce conditions less favorable to waterfowl because there would be less food and fewer trees, reducing the partitioning effect that creates isolated waterfowl courtship areas.

The amount of wooded streams, ephemeral wetlands, and tree cavities used by breeding waterfowl would remain at present levels under Alternative 1. Periodic drawdowns would maintain the 3,472 acres of interspersed open water and vegetation that provides brood habitat within Monopoly Marsh, Gum Stump, and Red Mill Pond.

Spring migration occurs from mid-January through early April and fall migration from mid-September through December with peak activity from October 1 to March 1. Migrating waterfowl are known to congregate within Pool 3, Pool 5, Pool 7 and Pool 8 as well as Monopoly Marsh, Rockhouse Marsh and the moist soil units. Under Alternative 1, public uses that occur on the Refuge would be segregated by location and time of year to minimize disturbance in these areas during peak migration activity.

Alternative 2

Under Alternative 2, the amount of migratory waterfowl using the Refuge is expected to remain stable or increase, barring changes in waterfowl numbers or migration patterns influenced by conditions beyond the Refuge. The amount of bottomland forest, open marsh, and moist soil management would remain at present levels. The quality of bottomland forest habitat is likely to increase because

of drainage improvements within 34 miles of the ditch system, an increase of 20 miles over Alternative 1. This is expected to largely eliminate prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades.

Improved drainage would help shift forest composition, increasing the amount of trees that produce hard mast of a size suitable for waterfowl food. Forest regeneration would increase the amount and quality of waterfowl courtship areas

The number of wooded streams used by breeding waterfowl is expected to remain at present levels under Alternative 2. The amount of ephemeral wetlands available to breeding waterfowl is likely to increase as drainage improves and flooding persists for shorter intervals within the bottomland forest. The amount of tree cavities may decrease because large scale forest die-off is expected to decrease, but individual trees as well as small groups of trees are expected to die as part of normal forest processes and would provide sufficient waterfowl nesting cavities. Periodic drawdowns would maintain the 3,472 acres of interspersed open water and vegetation that provides brood habitat within Monopoly Marsh, Gum Stump, and Red Mill Pond.

Under Alternative 2 the amount of disturbance within waterfowl breeding habitat is likely to increase. A 13-mile portion of the Auto Tour Route would be open from March 1 through November 30, an increase of 5 months over Alternative 1. This would increase the duration of human activity and the amount of disturbance. Allowing vehicle access would likely increase the amount of boating along Stanley Creek and Mingo River, from June through September, streams that otherwise would be accessible only by over land portage. Compared to Alternative 1, this is likely to increase the amount of disturbance to waterfowl along these streams during breeding season.

Spring migration occurs from mid-January through early April and fall migration from mid-September through December with peak activity from October 1 to March 1. Migrating waterfowl are known to congregate within Refuge streams, Pool 3, Pool 5, Pool 7, Pool 8, Monopoly Marsh, Rockhouse Marsh, Mingo Wilderness Area and the moist soil units. Under Alternative 2, a number of factors would increase disturbance of waterfowl in these areas. Expanded hunting opportunities, an increase of 500 visits annually over Alternative 1, would increase disturbance along Refuge streams, and within Pool 3, Pool 5, Pool 7, Pool 8, and the Mingo Wilderness Area. Disturbance may be greater in and around Pool 8 because, unlike Alternative 1, waterfowl hunting would be self-regulated. This would likely increase the number of hunters as well as any associated disturbance to waterfowl. Finally, designation of 8 miles of Red Mill Drive and Sand Blow Ridge Road as an interpretive auto tour route would likely increase vehicle traffic and the amount of disturbance along these road corridors. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 3

Under Alternative 3, the amount of migratory waterfowl using the Refuge is expected to remain stable or increase, barring changes in waterfowl numbers or migration patterns influenced by conditions beyond the Refuge. The amount of bottomland forest would increase by 1,205 acres to 16,205 acres, open marsh would decrease by 225 acres to 3,075 acres, and moist soil management would remain at present levels, but 80-90 acres would be managed as nesting habitat for King Rails and 10-20 acres managed as nesting habitat for Black Rails. The quality of bottomland forest habitat is likely to increase because of drainage improvements within 34 miles of the ditch system, an increase of 20 miles over the current management direction of Alternative 1. This is expected to largely eliminate prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades.

Improved drainage would help shift forest composition, increasing the amount of trees that produce hard mast of a size suitable for waterfowl food. Forest regeneration would increase the amount and quality of waterfowl courtship areas

The number of wooded streams used by breeding waterfowl is expected to remain at present levels under Alternative 3. The amount of ephemeral wetlands available to breeding waterfowl is likely to increase as drainage improves and flooding persists for shorter intervals within the bottomland forest. The number of tree cavities may decrease because large scale forest die-off is expected to decrease, but individual trees as well as small groups of trees are expected to die as part of normal forest processes and would provide sufficient waterfowl nesting cavities. Periodic drawdowns would maintain interspersed open water and vegetation that provides brood habitat within Monopoly Marsh, Gum Stump, and Red Mill Pond, but the total amount would drop by 245 acres or about 7 percent to 3,227 acres. This

decrease is not expected to adversely affect waterfowl breeding success.

Under Alternative 3 the amount of disturbance within waterfowl breeding habitat is likely to remain at present levels.

Spring migration occurs from mid-January through early April and fall migration from mid-September through December with peak activity from October 1 to March 1. Migrating waterfowl are known to congregate within Refuge streams, Pool 3, Pool 5, Pool 7, Pool 8, Monopoly Marsh, Rockhouse Marsh, Mingo Wilderness Area and the moist soil units. Under Alternative 3, disturbance of waterfowl within these areas is expected to be at or below present levels. All public uses would be prohibited year round along the entire 3-mile length of Sand Blow Ridge Road that surrounds Pool 5, and from October 1 to March 1 within 1,800 acres of the Mingo Wilderness Area, decreasing the amount of human disturbance during peak waterfowl migration. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 4

Under Alternative 4, the amount of migratory waterfowl using the Refuge is expected to remain stable or increase, barring changes in waterfowl numbers or migration patterns influenced by conditions beyond the Refuge. The amount of bottomland forest would increase by 547 acres to 15,547 acres, open marsh would decrease by 225 acres to 3,075 acres, and moist soil management would remain at present levels, but 80-90 acres would be managed as nesting habitat for King Rails and 10-20 acres managed as nesting habitat for Black Rails. The quality of bottomland forest habitat is likely to increase because of drainage improvements within 34 miles of the ditch system, an increase of 20 miles over the current management direction of Alternative 1. This is expected to largely eliminate prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades.

Improved drainage would help shift forest composition, increasing the amount of trees that produce hard mast of a size suitable for waterfowl food. Forest regeneration would increase the amount and quality of waterfowl courtship areas

The number of wooded streams used by breeding waterfowl is expected to remain at present levels under Alternative 4. The number of ephemeral wetlands available to breeding waterfowl is likely to increase as drainage improves and flooding persists for shorter intervals within the bottomland forest. The number of tree cavities may decrease because large scale forest die-off is expected to decrease, but individual trees as well as small groups of trees are expected to die as part of normal forest processes and would provide sufficient waterfowl nesting cavities. Periodic drawdowns would maintain interspersed open water and vegetation that provides brood habitat within Monopoly Marsh, Gum Stump, and Red Mill Pond, but the total amount would drop by 245 acres or about 7 percent to 3,227 acres.

Under Alternative 4 the amount of disturbance within waterfowl breeding habitat is likely to increase. A 13-mile portion of the Auto Tour Route would be open from March 1 through November 30, an increase of 5 months over Alternative 1. This would increase the duration of human activity and the amount of disturbance along this road corridor. Allowing vehicle access would likely increase the amount of boating along Stanley Creek and Mingo River, from June through September, streams that otherwise are accessible only by over land portage. Compared to Alternative 1, this is likely to increase the amount of disturbance to waterfowl along these streams during breeding season.

Spring migration occurs from mid-January through early April and fall migration from mid-September through December with peak activity from October 1 to March 1. Migrating waterfowl are known to congregate within Refuge streams, Pool 3, Pool 5, Pool 7, Pool 8, Monopoly Marsh, Rockhouse Marsh, Mingo Wilderness Area and the moist soil units. Under Alternative 4, a number of factors would increase disturbance of waterfowl in some of these areas, but decrease it in others. Expanded hunting opportunities, an increase of 500 visits annually over Alternative 1 and the same as Alternative 2, would increase disturbance within the 3,589 acres of Pool 3, Pool 5, Pool 7, and Pool 8. This is 6,891 acres less than is affected under Alternative 2. The designation of 8 miles of Red Mill Drive and Sand Blow Ridge Road as an interpretive auto tour route would likely increase vehicle traffic and the amount of disturbance along these road corridors. Finally, all public uses would be prohibited from October 1 to March 1 within 1,800 acres of the Mingo Wilderness Area, decreasing the amount of human disturbance during peak waterfowl migration. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

4.2.2.3 Shorebirds

Key analysis factors are:

- # mud flats with hiding cover and abundant and diverse invertebrates
- # suitable water depths
- # disturbance

Presently, Mingo NWR is used by migrating shorebirds primarily as stopover feeding habitat. Most migration occurs from March through May and again from July through November. Invertebrates found in seasonally exposed mud flats within Monopoly Marsh, Rockhouse Marsh, and some moist soil units provide a high energy food source. Shorebirds require low levels of disturbance as well as specific amounts of hiding cover and water depths that vary by species. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 1

Under Alternative 1, migrating shorebirds are expected to continue using the Refuge at present levels. Mud flats available for feeding shorebirds would remain at present levels, with the amount varying annually based on climatic conditions and water drawdown schedules. The amount of mud flats exposed within moist soil units would remain constant at about 235 acres annually. Rockhouse Marsh, which is completely drained every other year, and Monopoly Marsh, which is completely drained every fifth year, would provide varying amounts of mud flats annually. Under this water drawdown schedule, mud flats would be exposed 3 years out of 5 in these marshes. In the other 2 years both marshes would be at full pool, and exposed mud flats would be limited to those that result from evaporation or drought.

The micro variations in elevation within Rockhouse Marsh and Monopoly Marsh produce a range of water depths and a diverse vegetative mosaic that provides a range of hiding cover and fosters abundant invertebrates. Within moist soil units, water depths and hiding cover associated with mud flats would be more uniform, providing feeding habitat for a narrower range of shorebird species than seen in the mud flats of Rockhouse Marsh and Monopoly Marsh. But unlike the marshes, these units are less influenced by climatic variations and provide a more consistent food source.

Under Alternative 1, public uses that occur on the Refuge would be segregated by location and time of year to minimize disturbance in these areas during peak migration activity. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 2

Under Alternative 2, the environmental consequences to shorebirds of management within the moist soil units, Rockhouse Marsh, and Monopoly Marsh would be the same as described under Alternative 1.

Under this Alternative, 8 miles of Red Mill Drive and Sand Blow Ridge Road would be designated as an interpretive auto tour route, and a 6-mile loop around Gum Stump would be open to horseback riding, recreational biking, hiking, and jogging from March through September. This likely would increase the amount of disturbance occurring to migrating shorebirds along these routes. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 3

Under Alternative 3, migrating shorebirds are expected to use the Refuge at present or slightly increased levels. Monopoly Marsh would be drawn down incrementally to convert 225 acres to bottomland forest. This exposed area would provide additional shorebird feeding habitat in the short term (one to two growing seasons), but would disappear as forest succession proceeds. Otherwise the environmental consequences to shorebirds of management within Rockhouse Marsh and Monopoly Marsh would be the same as described under Alternative 1.

Moist soil management would change on about 100 acres in a way that favors shorebirds. Recently sprouted moist soil plants would be shallowly flooded from April through August 15. This would provide shorebird feeding habitat for a longer duration within moist soil units than under Alternatives 1and 2.

All public uses would be prohibited year round along the entire 3-mile length of Sand Blow Ridge Road that surrounds Pool 5, decreasing the amount of human disturbance to migrating shorebirds. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 4

Under Alternative 3, migrating shorebirds are expected to use the Refuge at present or slightly increased levels. Under Alternative 4, Monopoly

Marsh would be drawn down incrementally to convert 225 acres to bottomland forest. This exposed area would provide additional shorebird feeding habitat in the short term (one to two growing seasons), but would disappear as forest succession proceeds. Otherwise the environmental consequences to shorebirds of management within Rockhouse Marsh and Monopoly Marsh would be the same as described under Alternative 1.

Approximately 5 acres of old fields would be converted to shallow wetlands and would provide additional feeding habitat for shorebirds. Moist soil management would change on about 100 acres in a way that favors shorebirds. Recently sprouted moist soil plants would be shallowly flooded from April through August 15. This would provide shorebird feeding habitat for a longer duration within moist soil units than under Alternatives 1and 2.

Under this Alternative, 8 miles of Red Mill Drive and Sand Blow Ridge Road would be designated as an interpretive auto tour route, and a 6-mile loop around Gum Stump would be open to horseback riding, recreational biking, hiking, and jogging from March through September. This would likely increase the amount disturbance occurring to migrating shorebirds along these routes. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

4.2.2.4 Marsh Birds and Wading Birds

Key analysis factors are:

- # dense marsh vegetation
- # stable water levels (marsh birds)
- # variety of water depths (wading birds)
- # wetlands with abundant food resources (fish, reptiles, amphibians, seeds)
- # disturbance

Mingo NWR provides habitat for both migrating and nesting marsh birds and wading birds. Marsh birds, including bitterns, rails, grebes, and coots, are often secretive and difficult survey. Many nesting marsh birds require dense vertical cover, often of a single plant species, along with stable water levels. The type of vegetation and water levels varies by marsh bird species. Wading birds, which include herons and egrets, primarily feed by wading in shallow waters. They require wetlands with abundant prey and various water depths to accommodate a range of species. Both marsh birds and wading birds are sensitive to disturbance by humans. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 1

Under Alternative 1, marsh and wading birds are expected to continue using the Refuge at present levels. Sediment removal within 10 miles of the ditch system is expected to improve water level management. This would provide greater control over timing and duration of drawdowns conducted to enhance marsh vegetation used by marsh birds for nesting. It also would ensure stable water levels throughout the breeding season. Upgrading existing water control structures would further enhance water level management control and the ability to maintain stable water levels.

Periodic drawdowns of Monopoly Marsh and Rockhouse Marsh and willow removal within Rockhouse Marsh are expected to maintain open marsh habitat at present levels, providing feeding and nesting habitat for marsh birds and feeding habitat for wading birds. Exposed mud flats within moist soil units also would provide feeding and nesting for some marsh and wading birds. Notably, Yellow-crowned Night Herons and Black-crowned Night Herons, two species of management concern, would benefit from these changes.

Sediment removal within 10 miles of the ditch network is expected to improve fish habitat and increase the amount of ephemeral wetlands that remain after floodwaters recede within a portion of the bottomland forest. This would increase the amount of fish, amphibians, and reptiles available as food, and ephemeral wetlands would provide a range of water depths to accommodate a variety of marsh and wading bird species.

Alternative 2

Under Alternative 1, marsh birds are expected to use the Refuge at present or increased levels. Sediment removal within 34 miles of the ditch system is expected to improve water level management across the entire Refuge. Upgrading existing water control structures as well as reducing the depth of borrow pits adjacent to some moist soil units would further enhance water level management control and the ability to maintain stable water levels. These changes would provide greater control over timing and duration of drawdowns conducted to enhance marsh vegetation used by marsh birds for nesting. It also would ensure stable water levels throughout the breeding season.

Periodic drawdowns of Monopoly Marsh and Rockhouse Marsh and willow removal within Rockhouse Marsh are expected to maintain open marsh habitat at present levels, providing feeding and nesting habitat for marsh birds and feeding habitat for wading birds. Exposed mud flats within moist soil units also would provide feeding and nesting for some marsh and wading birds. The creation of about 5 acres of shallow wetlands is also expected to increase feeding habitat.

Sediment removal from the ditch system is expected to improve fish habitat and increase the number of ephemeral wetlands that remain after floodwaters recede across the entire 15,000 acres of bottomland forest. This would increase the amount of fish, amphibians, and reptiles available as food, and ephemeral wetlands would provide a range of water depths to accommodate a variety of marsh and wading bird species. Notably, Yellow-crowned Night Herons and Black-crowned Night Herons, two species of management concern, would benefit from these changes.

Under Alternative 2, wading bird use of the Refuge is expected to remain stable or increase. Sediment removal within 34 miles of the ditch network, a 24-mile increase over Alternative 1, is expected to improve fish habitat and increase the amount of ephemeral wetlands that remain after floodwaters recede across the entire area of bottomland forest. This would increase the amount of fish, amphibians, and reptiles fed on by wading birds, and ephemeral wetlands would provide a range of water depths to accommodate a variety of wading bird species. Additional feeding habitat also would come from the creation of 20 acres of open water and increased amounts of scoured wetlands. Tree drops and fish stocking proposed under this alternative would increase fish numbers, providing additional food. Tree drops also would be used by wading birds for hunting and resting. Sloping the sides of borrow pits would make them shallower, exposing amphibians to greater predation. In the short term this would increase food availability for wading birds, but in the long term it would reduce the amount of habitat for amphibians decreasing their numbers.

The focus on expanding public use under Alternative 2 is expected to increase disturbance of marsh birds and wading birds. A 13-mile portion of the Auto Tour Route would be open from March 1 through November 30, an increase of 5 months over Alternative 1. This would increase the duration of human activity and the amount of disturbance. Allowing vehicle access would likely increase the amount of boating along Stanley Creek and Mingo River, from June through September, streams that otherwise would be accessible only by over land portage. Compared to Alternative 1, this is likely to increase the amount of disturbance, especially to wading birds, along these streams. Designation of 8 miles of Red Mill Drive and Sand Blow Ridge Road as an interpretive auto tour route would likely increase vehicle traffic and the amount of disturbance along these road corridors. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 3

Under Alternative 3, a greater number of marsh birds are expected to use the Refuge. The consequences of ditch sediment removal on water level management and marsh management are the same as described for Alternative 2.

Sediment removal from the ditch system is expected to improve fish habitat and increase the number of ephemeral wetlands that remain after floodwaters recede across the entire 16,205 acres of bottomland forest. This would increase the amount of fish, amphibians, and reptiles available as food, and ephemeral wetlands would provide a range of water depths to accommodate a variety of marsh and wading bird species. Notably, Yellow-crowned Night Herons and Black-crowned Night Herons, two species of management concern, would benefit from these changes.

Moist soil management would change on about 100 acres in a way that favors marsh birds, especially rails. Recently sprouted moist soil plants would be shallowly flooded from April through August 15. These areas are expected to provide nesting habitat for King Rails and Black Rails.

Under Alternative 3, more wading birds are expected to use the Refuge. Sediment removal within 34 miles of the ditch network, a 24-mile increase over Alternative 1, is expected to improve fish habitat and increase the amount of ephemeral wetlands that remain after floodwaters recede across the entire area of bottomland forest. This would increase the amount of fish, amphibians, and reptiles fed on by wading birds, and ephemeral wetlands would provide a range of water depths to accommodate a variety of wading bird species. Additional feeding habitat also would come from an increased amount of vernal pools. Tree drops and fish stocking proposed under this alternative would

increase fish numbers, providing additional food. Tree drops also would be used by wading birds for hunting and resting.

Under Alternative 3, a number of factors are expected to decrease the amount of disturbance to marsh and wading birds. All public uses would be prohibited year-round along the entire 3-mile length of Sand Blow Ridge Road that surrounds Pool 5, and from October 1 to March 1 within 1,800 acres of the Mingo Wilderness Area. Also, gathering of wild edibles would be prohibited. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

Alternative 4

Under Alternative 4, marsh birds are expected to use the Refuge at increased levels. The consequences of ditch sediment removal on water level management and marsh management are the same as described for Alternative 2.

Sediment removal from the ditch system is expected to improve fish habitat and increase the number of ephemeral wetlands that remain after floodwaters recede across the entire 15,547 acres of bottomland forest. This would increase the amount of fish, amphibians, and reptiles available as food, and ephemeral wetlands would provide a range of water depths to accommodate a variety of marsh and wading bird species. Notably, Yellow-crowned Night Herons and Black-crowned Night Herons, two species of management concern, would benefit from these changes.

Moist soil management would change on about 100 acres in a way that favors marsh birds, especially rails. Recently sprouted moist soil plants would be shallowly flooded from April through August 15. These areas are expected to provide nesting habitat for King Rails and Black Rails.

Under Alternative 4, wading bird use of the Refuge is expected to increase. Sediment removal within 34 miles of the ditch network, a 24-mile increase over Alternative 1, is expected to improve fish habitat and increase the number of ephemeral wetlands that remain after floodwaters recede across the entire area of bottomland forest. This would increase the amount of fish, amphibians, and reptiles fed on by wading birds, and ephemeral wetlands would provide a range of water depths to accommodate a variety of wading bird species. Additional feeding habitat also would come from the creation of 20 acres of open water and 10 acres of shallow wetlands, and an increased amount of vernal pools. Tree drops and fish stocking proposed under this alternative would increase fish numbers, providing additional food. Tree drops also would be used by wading birds for hunting and resting. Sloping the sides of borrow pits would make them shallower, exposing amphibians to greater predation. In the short term this would increase food availability for wading birds, but in the long term it would reduce the amount of habitat for amphibians decreasing their numbers.

Under Alternative 4, the amount of area available for gathering wild edibles would decrease compared to the current management direction of Alternative 1, and would decrease the amount of disturbance to marsh and wading birds. A number of other factors are expected to increase disturbance of marsh birds and wading birds. A 13-mile portion of the Auto Tour Route would be open from March 1 through November 30, an increase of 5 months over Alternative 1. This would increase the duration of human activity and the amount of disturbance. Allowing vehicle access would likely increase the amount of boating along Stanley Creek and Mingo River, from June through September, streams that otherwise would be accessible only by over land portage. Compared to Alternative 1, this is likely to increase the amount of disturbance, especially to wading birds, along these streams. Designation of 8 miles of Red Mill Drive and Sand Blow Ridge Road as an interpretive auto tour route would likely increase vehicle traffic and the amount of disturbance along these road corridors. See Section 4.2.2.11 on page 170 for additional discussion of wildlife disturbance.

4.2.2.5 Land Birds

Key analysis factors are:

- forest species and age class diversity
- temporary forest openings
- contiguous bottomland forest blocks

Mingo NWR is situated at the interface of the Ozark Highlands and Crowley's Ridge, encompassing portions of each along with the bottomlands between. It includes a diverse range of habitats that provide for the nesting and migratory needs of many migratory landbirds. Species including Cerulean Warbler, Prothonotary Warbler, and Swainson's Warbler are of particular concern at Mingo NWR. Cerulean Warblers prefer forests with large trees towering above a multi-layered canopy and interrupted by frequent canopy gaps. The Prothonotary Warbler is a cavity nester found in bottomland forests, and Swainson's Warblers favor

breeding sites that are moist but not flooded with an understory of cane.

Alternative 1

Under Alternative 1, land bird use of the Refuge is expected to remain stable or slightly increase. Sediment removal within 10 miles of the ditch system is expected to shorten flood duration and promote regeneration within a portion of the 15,000-acre bottomland forest. In the affected areas, forest species composition would increase as less flood tolerant tree species return. Also, young forest is expected to appear on some sites presently dominated by buttonbush and trees killed from years of prolonged flooding, as well as within temporary openings created by fallen trees. Such forest renewal will slowly improve age class diversity within the relatively even-aged bottomland forest, restoring the multi-layered canopy favored by many land birds including Cerulean Warblers, Prothonotary Warblers, and Swainson's Warblers.

Under Alternative 1, drainage along much of the ditch system would not be improved by removal of sediments, and some portions of the bottomland forest may continue to die and not be replaced or become dominated by species with greater flood tolerances. In the long term this may decrease bottomland forest habitat or reduce the complexity of the habitat, diminishing its value to land birds

Alternative 2

Under Alternative 2, land bird use of the Refuge is expected to increase. The quality of bottomland forest habitat is likely to increase because of drainage improvements within 34 miles of the ditch system, an increase of 20 miles over Alternative 1. This is expected to largely eliminate prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades. Forest species composition would slowly increase as less flood tolerant tree species return. Also, young forest is expected to appear on most if not all sites presently dominated by buttonbush and flood-killed trees as well as within temporary openings created by fallen trees. Such forest renewal will slowly improve age class diversity within the relatively even-aged bottomland forest, restoring the multi-layered canopy favored by many land birds including Cerulean Warblers, Prothonotary Warblers, and Swainson's Warblers.

The number of tree cavities may decrease because large scale forest die-off is expected to end, but individual trees as well as small groups of trees are expected to die as part of normal forest processes and would provide sufficient nesting cavities.

Alternative 3

Under Alternative 3, land bird use of the Refuge is expected to increase. The amount of bottomland forest would increase by 1,205 acres and the quality of the habitat would increase because of drainage improvements within 34 miles of the ditch system, an increase of 20 miles over Alternative 1. This is expected to largely eliminate prolonged flooding that has killed large areas of mature trees and prevented forest regeneration in recent decades. Forest species composition would slowly increase as less flood tolerant tree species return. Also, young forest is expected to appear on most if not all sites presently dominated by buttonbush and flood-killed trees as well as within temporary openings created by fallen trees. Such forest renewal will slowly improve age class diversity within the relatively even-aged bottomland forest. In some places forest management activities such as thinning and selective tree cutting would speed changes in age class diversity and tree species composition. These changes would help restore the multi-layered canopy favored by many land birds including Cerulean Warblers, Prothonotary Warblers, and Swainson's Warblers.

The conversion of 980 acres of grassy openings, cropland, and food plots to bottomland forest would eliminate habitat for land birds associated with these habitats, but some sites would likely to include cane, a species favored by Swainson's Warblers. The number of tree cavities may decrease because large scale forest die-off is expected to end, but individual trees as well as small groups of trees are expected to die as part of normal forest processes and would provide sufficient nesting cavities.

Alternative 4

The environmental consequences to land birds are the same as those described under Alternative 3 with two exceptions. Bottomland forest habitat would increase by 547 acres, which is 658 acres less than in Alternative 3. The 980 acres of grassy openings, cropland, and food plots would be converted to 332 acres of bottomland forest, 112 acres of oak savanna, and 15 acres of cane. This produces fewer acres of bottomland forest but increases the amount of cane, which is favored by Swainson's Warblers.

4.2.2.6 Other Wildlife

Fish and Aquatic Species

Key analysis factors are:

- # water quality and depth
- # submerged structure
- # spawning and nursery habitat
- # barriers to fish movement

The ditches, streams, and other open water of Mingo NWR harbor a diverse assemblage of fish and aquatic species including several that are locally abundant but rare across Missouri. Fish and aquatic species are sensitive to changes in water quality, and to barriers that prevent fish movement. Many require deep water habitats with sufficient submerged structure such as fallen trees.

Alternative 1

Under Alternative 1, fish and aquatic species are expected to remain at present levels or slightly increase. Sediment would be removed from 10 miles of the ditch network improving habitat for game fish and other aquatic species by increasing water movement and water depth.

Periodic draw downs of Monopoly Marsh and Rockhouse Marsh would compact bottom sediments that otherwise decrease water quality, and stimulate growth of aquatic vegetation that provides feeding, spawning, and nursery habitat.

Several water control structures would be modified to enhance a bottom-of-the-water-column draw and designed to enhance fish passage. The bottom draw from the water column enhances the removal of sediment from the ditches, improving water quality and preventing future accumulation of sediment, which protects the deep water habitat restored during the ditch cleaning process. The fish passage enhancements remove existing barriers and promote fish movement from spawning, nursery, and foraging habitat.

Under Alternative 1, 200 acres of open water including some deep water habitat would be available.

Alternative 2

Fish and aquatic species are expected to increase above present levels and exceed the amount that would be present under Alternative 1. Sediment would be removed from 34 miles of the ditch system, 20 miles more than under Alternative 1. These improvements will increase deep water habitat critical during low oxygen periods in the winter and hot summer months and remove sediment that otherwise would be suspended in the water column, improving water quality.

Similar to Alternative 1, periodic draw downs of Monopoly Marsh and Rockhouse Marsh would compact bottom sediments that otherwise decrease water quality, and stimulate growth of aquatic vegetation that provides feeding, spawning, and nursery habitat.

Similar to Alternative 1, several water control structures would be modified to enhance a bottom-of-the-water-column draw and designed to enhance fish passage. The bottom draw from the water column enhances the removal of sediment from the ditches, improving water quality and preventing future accumulation of sediment, which protects the deep water habitat restored during the ditch cleaning process. The fish passage enhancements remove existing barriers and promote fish movement from spawning, nursery, and foraging habitat.

Under this Alternative, staff would establish a partnership with the Missouri Department of Conservation. The cooperative effort would investigate and potentially reintroduce the extirpated alligator gar. This would return a native predator and help balance predator prey relationships, restoring biological integrity of the system. This will also include restocking native game species as appropriate.

The creation of 20 acres of open water would increase the total amount of open water to 220 acres.

Hartz Pond and Fox Pond would be improved by enhancing existing deep water habitat. Trees would be dropped into deep water habitats to increase fish hiding cover.

Under Alternative 2, a full-time law enforcement officer would be added to existing staff. The officer would enforce fishing regulations reducing illegal harvest and help preserve the health and abundance of Refuge fisheries.

Alternative 3

Fish and aquatic species are expected to increase above present levels and exceed the amount that would be present under Alternative 1. Sediment would be removed from 34 miles of the ditch system, 20 miles more than under Alternative 1. These improvements will increase deep water habitat critical during low oxygen periods in the winter and hot summer months and remove sediment that other-

wise would be suspended in the water column, improving water quality.

Similar to Alternatives 1 and 2, periodic draw downs of Monopoly Marsh and Rockhouse Marsh would compact bottom sediments that otherwise decrease water quality, and stimulate growth of aquatic vegetation that provides feeding, spawning, and nursery habitat.

Similar to Alternative 1 and 2, several water control structures would be modified to enhance a bottom-of-the-water-column draw and designed to enhance fish passage. The bottom draw from the water column enhances the removal of sediment from the ditches, improving water quality and preventing future accumulation of sediment, which protects the deep water habitat restored during the ditch cleaning process. The fish passage enhancements remove existing barriers and promote fish movement from spawning, nursery, and foraging habitat.

Under Alternative 3, fish passage would be enhanced in Monopoly Marsh and Rockhouse Marsh, providing additional spawning and nursery habitat. Refuge staff would work with Corps of Engineers staff at Lake Wappapello to modify discharge rates to increase fish passage at the spillway located on Ditch 11. This would increase the genetic variability of the St. Francis floodplain fisheries restocking the Refuge. Under this Alternative, the spillway structure would be modified, the host species of the mussel species utilizing the Refuge would be identified, and missing known host species would be reintroduced resulting in enhanced aquatic resources.

Under this alternative, Refuge personnel would work with Missouri Department of Conservation fisheries research staff to evaluate existing fisheries resources and help implement recommendations to improve fisheries resource. This partnership would include cooperative effort to investigate and potentially reintroduce the extirpated alligator gar. This would return a native predator and help balance predator prey relationships, restoring biological integrity of the system. This would also include restocking native game species as appropriate.

Unlike Alternatives 1 and 2, an additional 5 acres of vernal and ephemeral wetlands would be created in the bottomland hardwood forests. These pools are expected to supply additional spawning and nursery habitat. Gum Stump would decrease by 20 acres reducing the total amount of open water to 180 acres. Fox Pond would be improved by enhancing existing deep water habitat. Trees would be dropped into deep water habitats to increase fish hiding cover. Bow fishing would be eliminated to protect reintroduced alligator gar until populations are adequate to support recreational harvest.

Several off-Refuge strategies support working with adjacent private landowners and State and Federal partners along watersheds entering the Refuge. These strategies would reduce sediments entering the Refuge waterways, resulting in improved water quality and an increase in abundance and diversity of aquatic resources.

Like Alternative 2, a full-time law enforcement officer would be added to existing staff. The officer would enforce fishing regulations reducing illegal harvest and help preserve the health and abundance of Refuge fisheries.

Alternative 4

The environmental consequences to fish and aquatic species are the same as those described under Alternative 3 with following exceptions. The creation of 20 acres of open water would offset a 20-acre reduction in the size of Gum Stump maintaining the total amount of open water at 200 acres. In addition to Fox Pond, Hartz Pond would be improved by enhancing existing deep water habitat. Finally, the amount of vernal and ephemeral wetlands created in bottomland forest would increase to a total of 10 acres.

4.2.2.7 Reptiles and Amphibians

Key analysis factors are:

ephemeral wetlands
vernal pools
human caused mortality and disturbance

Mingo NWR is known for harboring abundant populations of reptiles and amphibians. Amphibians are dependent on vernal pools and ephemeral wetlands as breeding sites. Reptiles and amphibians migrate between the bottomlands where they breed and feed and the surrounding bluffs where they hibernate through the winter months. Reptiles and amphibians are present in large numbers on Refuge roads, especially a 13-mile portion of the Auto Tour Route, during these migrations and are susceptible to mortality caused by vehicles.

Alternative 1

Under Alternative 1, reptiles and amphibians are expected to remain at present levels or slightly

increase. Sediment removal within 10 miles of the ditch network is expected to increase the amount of ephemeral wetlands that remain after floodwaters recede within a portion of the bottomland forest. At Mingo NWR, years of prolonged flooding caused by slow drainage meant these shallow water habitats did not form in time for amphibian breeding seasons. Because much of the ditch system would remain clogged with sediment there would continue to be a lack of ephemeral wetlands within much of the bottomland forest.

Under Alternative 1, there would be no change to vehicle use along a 13-mile portion of the Auto Tour Route. It is likely that vehicle-caused mortality of reptiles and amphibians would continue at present rates along the roadway during spring and fall migrations.

Alternative 2

Under Alternative 2, populations of reptiles and amphibians are expected to increase. Sediment removal within 34 miles of the ditch system, a 24-mile increase over Alternative 1 is expected to increase the amount of ephemeral wetlands across the entire 15,000-acre bottomland forest providing additional breeding sites for amphibians. The creation of an additional 20 acres of open water also would provide additional breeding habitat. Trees intentionally felled into open water habitats would provide basking areas for snakes and turtles. Sloping the sides of borrow pits would make them shallower, exposing amphibians such as amphiumas and sirens to greater predation and reducing the amount of this habitat.

Under this Alternative a number of factors are expected to increase human-caused mortality of reptiles and amphibians. A 13-mile portion of the Auto Tour Route would be open from March through November, an increase of 5 months over Alternative 1. Eight miles of Red Mill Drive and Sand Blow Ridge Road would be designated as an interpretive auto tour route, and a 6-mile loop around Gum Stump would be open to horseback riding, recreational biking, hiking, and jogging from March through September. This likely would increase the amount of disturbance and mortality of reptiles and amphibians along these routes.

Closing a 13-mile portion of the Auto Tour Route during spring and fall reptile and amphibian migrations and increasing focus on amphibians and reptiles in Refuge environmental education and interpretation materials is expected to decrease mortality. Also, the addition of a full-time law enforcement officer under this alternative is expected to decrease mortality by improving compliance with federal regulations regarding unlawful take and disturbance of wildlife. Finally, increased monitoring proposed under this alternative would help focus Refuge policies and management of reptiles and amphibians.

Alternative 3

Under Alternative 3, populations of reptiles and amphibians are expected to increase. Sediment removal within 34 miles of the ditch system, a 24-mile increase over Alternative 1 is expected to increase the number of ephemeral wetlands across the entire 15,000-acre bottomland forest providing additional breeding sites for amphibians. More scoured wetlands and vernal pools also would provide additional breeding habitat largely free of fish and other aquatic predators. Trees intentionally felled into open water habitats would provide basking areas for snakes and turtles.

Closing a 13-mile portion of the Auto Tour Route during spring and fall reptile and amphibian migrations and increasing focus on amphibians and reptiles in Refuge environmental education and interpretation materials is expected to decrease mortality along Refuge roadways. Also, the addition of a full-time law enforcement officer under this alternative is expected to decrease mortality by improving compliance with federal regulations regarding unlawful take and disturbance of wildlife. Finally, increased monitoring proposed under this alternative would help focus Refuge policies and management of reptiles and amphibians.

Alternative 4

Under Alternative 4, populations of reptiles and amphibians are expected to increase. Sediment removal within 34 miles of the ditch system, a 24-mile increase over Alternative 1, is expected to increase the amount of ephemeral wetlands across the entire 15,000-acre bottomland forest providing additional breeding sites for amphibians. Additional breeding habitat also would come from the creation of 20 acres of open water and increased amounts of scoured wetlands and vernal pools. The latter would provide breeding habitat largely free of fish and other aquatic predators. Trees intentionally felled into open water habitats would provide basking areas for snakes and turtles. Sloping the sides of borrow pits would make them shallower, exposing amphibians such as amphiumas and sirens to

greater predation and reducing the amount of this habitat. More scoured wetlands and vernal pools would provide additional breeding habitat largely free of fish and other aquatic predators.

Under this Alternative a number of factors are expected to increase human-caused mortality of reptiles and amphibians. A 13-mile portion of the Auto Tour Route would be open from March through November an increase of 5 months over Alternative 1. Eight miles of Red Mill Drive and Sand Blow Ridge Road would be designated as an interpretive auto tour route, and a 6-mile loop around Gum Stump would be open to horseback riding, recreational biking, hiking, and jogging from March through September. This likely would increase the amount of disturbance and mortality of reptiles and amphibians along these routes.

Closing a 13-mile portion of the Auto Tour Route during spring and fall reptile and amphibian migrations and increasing focus on amphibians and reptiles in Refuge environmental education and interpretation materials is expected to decrease mortality. Also, the addition of a full-time law enforcement officer under this alternative is expected to decrease mortality by improving compliance with federal regulations regarding unlawful take and disturbance of wildlife. Finally, increased monitoring proposed under this alternative would help focus Refuge policies and management of reptiles and amphibians.

4.2.2.8 Wildlife Associated with Early Successional Habitats

Key analysis factors are:

permanent and temporary openings
forest regeneration

Early successional habitats, especially those associated with temporary and permanent forest openings, are part of the historic vegetative condition of the Refuge. Fire, wind, and other disturbance agents likely kept about 3-5 percent (450-750 acres at Mingo NWR) of bottomland forests in temporary openings referred to as tree-gaps (Heitmeyer et al, 2005; Hartshorne, 1980; Heitmeyer et al, 1989; King and Antrobus, 2001). Caused by death or windthrow of one or more trees, these temporary open habitats within the forest are normally short-lived because they are quickly colonized by herbaceous plants, shrubs, and tree seedlings. These temporary openings provide diversity within the otherwise forested matrix, and are important habitat for wildlife such as swamp rabbits, white-tailed deer, quail, and Swainson's Warblers. At Mingo NWR, years of prolonged annual floods caused by poor drainage impeded colonization of tree-gaps by plants and young trees, eliminating much of this habitat.

Permanent grassy openings, like those seen along Crowley's Ridge, are part of the historic vegetative condition within the upland portions of the Refuge that grade from the bottomlands into the surrounding bluffs (Dr. Leigh Fredrickson and Dr. Micky Heitmeyer, personal communication). These openings also provide early successional habitat.

Alternative 1

Under Alternative 1, the amount of early successional habitat would remain at present levels including 411 acres of grassy openings, 471 acres of cropland, and 95 acres of food plots as well as 704 acres of moist soil management a third of which is cropped annually. These sites are expected to attract wildlife, such as turkey and white-tailed deer, associated with early successional habitats.

Sediment removal within 10 miles of the ditch system is expected to shorten flood duration and promote regeneration within a portion of the 15,000-acre bottomland forest. Within this area, young forest is expected to appear on some sites presently dominated by buttonbush and trees killed from years of prolonged flooding, as well as within temporary openings created by fallen trees. Such forest renewal will improve age class diversity and provide habitat for wildlife associated with early successional habitat such as swamp rabbits.

Alternative 2

Under Alternative 2, the amount of grassy openings, cropland, and food plots would remain at present levels, the same as described in Alternative 1.

Sediment removal within 34 miles of the ditch system is expected to shorten flood duration and promote regeneration within the entire area of bottomland forest, a greater extent than under Alternative 1. Young forest is expected to appear on most if not all sites presently dominated by buttonbush and trees killed by years of prolonged flooding, as well as within temporary openings created by fallen trees. Such forest renewal will improve age class diversity and provide habitat for wildlife associated with early successional habitat such as swamp rabbits.

Alternative 3

Under Alternative 3, all 980 acres of grassy openings, cropland, and food plots would be converted to bottomland forest. In the short term these sites would to continue serve as early successional habitat, but in the long term, as the forest ages and the canopy closes, it would be eliminated.

Sediment removal within 34 miles of the ditch system is expected to shorten flood duration and promote regeneration within the entire area of bottomland forest, a greater extent than under Alternative 1. Young forest is expected to appear on most if not all sites presently dominated by buttonbush and trees killed by years of prolonged flooding, as well as within temporary openings created by fallen trees. In some places forest management activities such as thinning and selective tree cutting would open the forest canopy, which would allow more sunlight to reach the forest floor and stimulate new growth. Such forest renewal would improve age class diversity and provide habitat for wildlife associated with early successional habitat such as swamp rabbits.

Alternative 4

Alternative 3 would maintain 531 acres of grassy openings, cropland, and food plots. The remaining 449 acres of openings would be converted to 322 acres of bottomland forest, 112 acres of oak savanna, and 15 acres of cane. In the short term the 322 acres converted to bottomland forest would continue to serve as early successional habitat, but in the long term, as the forest ages and the canopy closes, it would be eliminated. The areas converted to oak savanna and cane would continue to provide early successional habitat.

Sediment removal within 34 miles of the ditch system is expected to shorten flood duration and promote regeneration within the entire area of bottomland forest, a greater extent than under Alternative 1. Young forest is expected to appear on most if not all sites presently dominated by buttonbush and trees killed by years of prolonged flooding, as well as within temporary openings created by fallen trees. In some places forest management activities such as thinning and selective tree cutting would open the forest canopy and allow more sunlight to reach the forest floor, stimulating new growth. Such forest renewal would improve age class diversity and provide habitat for wildlife associated with early successional habitat such as swamp rabbits.

4.2.2.9 Cultural Resources and Historic Preservation

The consequences of each alternative in terms of cultural resources are the same:

Undertakings accomplished on the Refuge have the potential to impact cultural resources. Although the presence of cultural resources including historic properties cannot stop a Federal undertaking, the undertakings are subject to Section 106 of the National Historic Preservation Act and sometimes other laws.

Thus the Refuge Manager will, during early planning, provide the Regional Historic Preservation Officer a description and location of all projects, activities, routine maintenance and operations that affect ground and structures, and requests for permitted uses; and of alternatives being considered. The RHPO will analyze these undertakings for potential to affect historic properties and enter into consultation with the State Historic Preservation Officer and other parties as appropriate. The Refuge Manager will notify the public and local government officials to identify concerns about impacts by the undertaking; this notification will be at lease equal to, preferably with, public notification accomplished for NEPA and compatibility.

4.2.2.10 Wilderness

Key analysis factors:

wilderness character
air quality
public awareness and appreciation

The Mingo Wilderness Area is 7,730 acres and is a Class I air quality area. This requires developers to consider air quality effects and obtain permits from the associated department of natural resources agencies for specific construction activities. By legislative mandate, staff manage the area to preserve its wilderness character and foster an appreciation and awareness by the general public.

Alternative 1

Currently, the following activities are conducted to preserve the Wilderness character, protect the air quality, and increase public awareness: maintaining wilderness boundary and signage, restricting illegal entry, providing assistance to the Air Quality Branch in Denver, Colorado reviewing air quality permit requests, operating air monitoring stations, and conducting educational programming focusing on the Leave No Trace initiative.

Table 4: Percentage of total Refuge acres affected by month from wildlife disturbance along selected corridors

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alternative 1	7.6	7.6	7.6	7.6	7.9	7.9	7.9	7.9	7.9	7.6	7.6	7.6
Alternative 2	7.6	7.6	9.3	9.3	9.5	9.5	9.5	9.5	9.5	7.6	7.6	7.6
Alternative 3	6.7	6.7	6.7	6.7	7.0	7.0	7.0	7.0	7.0	6.7	6.7	6.7
Alternative 4	7.6	7.6	9.3	9.3	9.5	9.5	9.5	9.5	9.5	7.6	7.6	7.6
	Peak Waterfowl Migration Months											

Alternative 2

Under this Alternative, in addition to the activities outlined in Alternative 1, outreach will be emphasized to promote appreciation and awareness of this unique resource. Photo monitoring and installation of a webcam with a live downlink will further the connection to the Wilderness and monitoring of air quality.

Alternative 3

In addition to what is discussed under Alternative 1 and Alternative 2, staff will receive additional training in wilderness management, additional monitoring will take place including mercury and other contamination, and management programs will be adjusted to ensure that natural hydrologic processes are mimicked. This includes providing sheet flow compatible with the natural basin's drainage.

Alternative 4

Alternative 4 embraces all aspects identified in previous alternatives resulting in the maximum habitat benefits, public awareness and appreciation, and preservation of the wilderness character of the area.

4.2.2.11 Wildlife Disturbance

Mingo NWR offers opportunities for six priority wildlife-dependent public uses: hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation. In addition the Refuge also offers opportunities for the following uses: horseback riding, recreational biking, hiking, jogging, boating, canoeing, kayaking, wild edibles gathering, and picnicking. The potential to disturb wildlife is an element common to all uses occurring on the Refuge. This analysis discusses the amount of potential wildlife disturbance from these uses for all alternatives.

Studies by Blumstein (2003) and Blumstein et al (2003) show that 'flight-initiation-distance' varies by species and intruder starting distance as well as by flock size, angle of approach, time of year, time of day, reproductive state, distance to refuge, and type of disturbance. Given these complexities, it is not possible to determine the level of disturbance generated by each activity. It is likely there is a zone of influence on either side of existing travel ways where some level of wildlife disturbance occurs from all sources. It is also likely that wildlife disturbance is more widespread for activities not confined to a corridor such as a road or trail.

There are no specific studies regarding wildlife disturbance at Mingo NWR, but a study conducted in and around Boulder, Colorado, Miller et al. (1998) found that composition and abundance of birds were altered adjacent to trails in both grassland and forest ecosystems. The authors noted the cause could be the physical presence of the trail, associated human disturbance, or both factors acting in concert. These effects, for most bird species, were largely confined to a zone of influence extending approximately 250 feet on either side of trails and may be less pronounced in areas with less human development and recreational use than the study area.

We applied this concept as one measure of potential wildlife disturbance from vehicle traffic, horseback riding, recreational biking, hiking, and jogging along specified travel ways at Mingo NWR. Figure 2 and Figure 3 show the duration and location of Refuge roads open to these activities for each alternative. Table 4 shows amount of travel ways open to these activities as well as the associated zone of influence (250 feet on either side of travel ways) in percentage of total Refuge acres for each alternative.

Alternative 1 represents the amount of the Refuge subject to disturbance from these activities under current management direction. The amount increases above present levels for Alternatives 2

Figure 2: Horseback Riding, Recreational Biking, Hiking, and Jogging Use Permitted, Mingo NWR

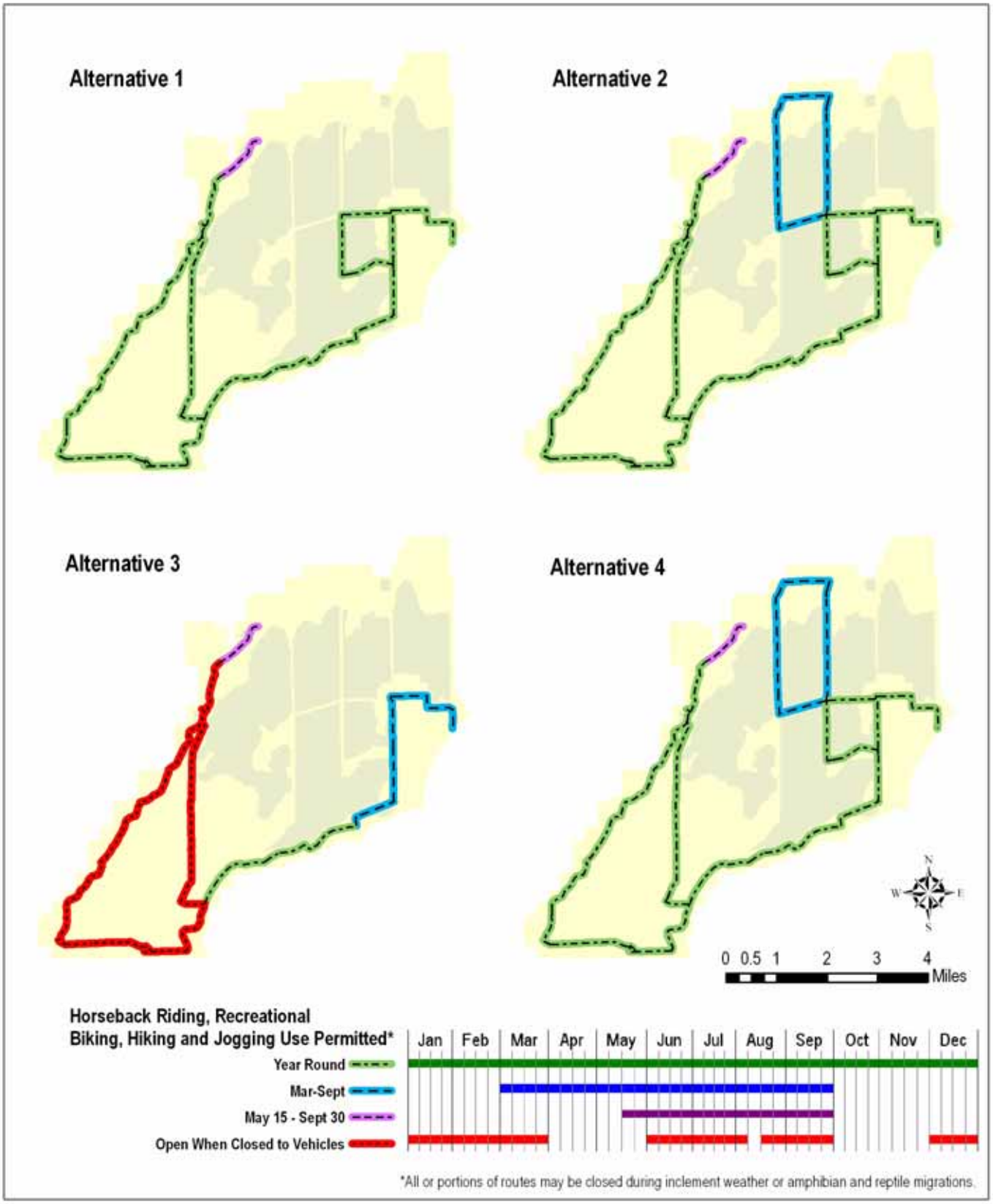
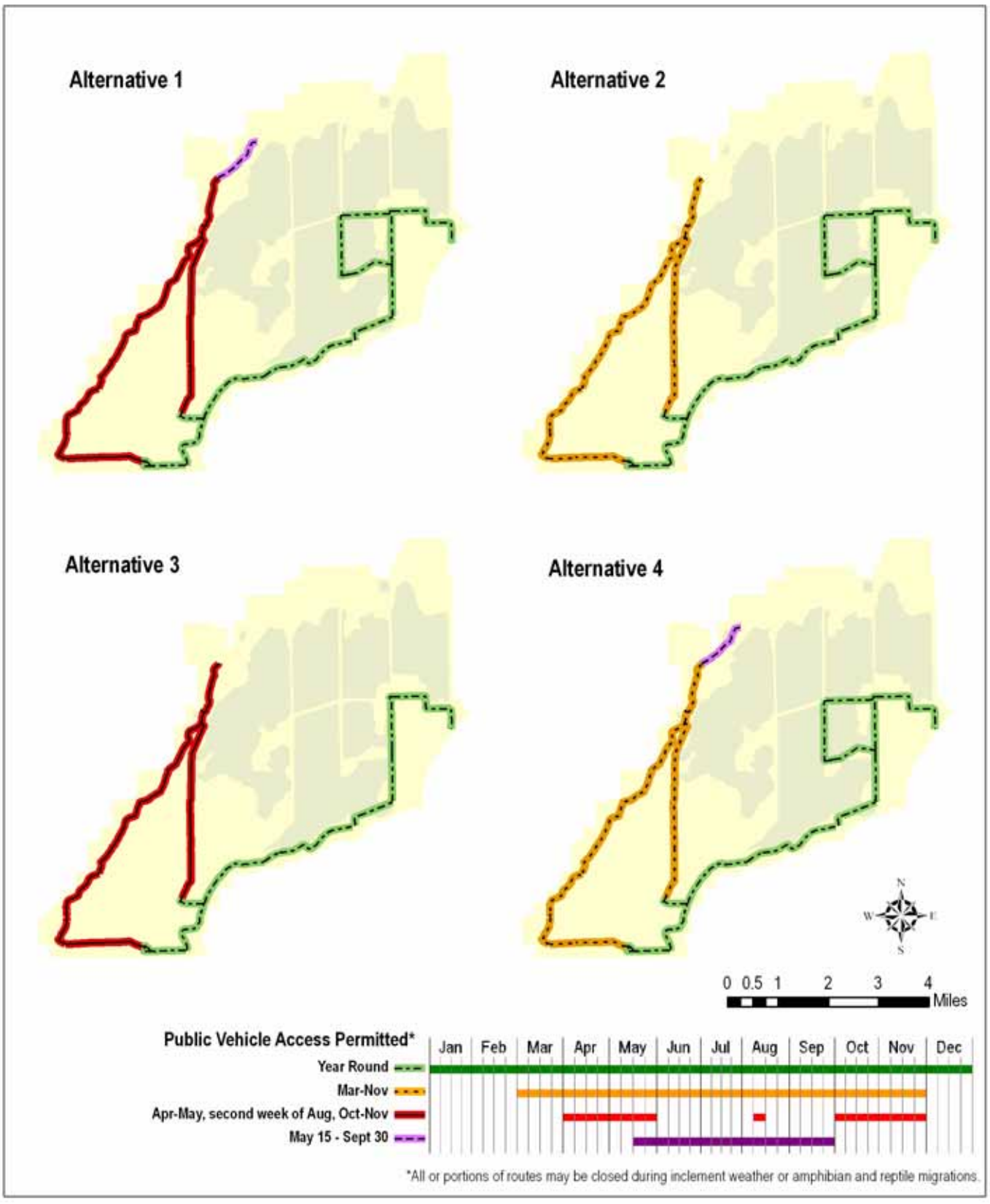


Figure 3: Public Vehicle Access Permitted, Mingo NWR



and 4, and decreases under Alternative 3. Under all alternatives, less than 10 percent of the Refuge is affected by these activities in any month, and within each alternative the potential for disturbance is lowest during times of peak waterfowl migration.

Wildlife-dependent recreation activities as well as boating, canoeing, kayaking, wild edibles gathering, and picnicking also cause disturbance of wildlife. The effect of these activities is more difficult to quantify, but it is likely that the potential for wildlife disturbance is the greatest under Alternative 2 with its focus on expanding public use. It is lowest under Alternative 3 with its focus on wildlife habitat. Picnicking and wild edibles gathering are eliminated under Alternative 3, and a 1,800-acre area would be closed to all uses from October through February. The amount of public use proposed under Alternative 4 is similar to that proposed under Alternative 2, but the potential for wildlife disturbance is expected to be less than Alternative 2 because of the elimination of picnicking, and the inclusion of an 1800-acre area closed to all uses from October through February. A youth firearms deer hunt proposed under Alternatives 2 and 4 would be the first fall firearms hunt in the history of the Refuge, but limiting the extent and number participants would minimize disturbance to wildlife.

4.2.3 Cumulative Impacts Analysis

"Cumulative impact" is the term that refers to impacts on the environment that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In this section, the cumulative impacts of each of the four alternatives are discussed in terms of bottomland forests and environmental education.

Bottomland Hardwood Forests

Mingo NWR is adjacent to the Service's designated Lower Mississippi River Ecosystem, which once supported a vast bottomland hardwood forest complex that extended along the Mississippi River and its many tributaries from Illinois to Louisiana. Less than two centuries after widespread settlement of the region by Euro-Americans began in earnest, less than 20 percent of the bottomland hardwood forest survives and most of what does remain is fragmented or scattered in patches throughout the region.

Mingo NWR protects a remnant of the bottomland hardwood and cypress-tupelo swamp ecosystem which once formed a 2.5-million acre contiguous natural landscape throughout the Mississippi River basin. The 21,592-acre Refuge represents the largest area in southeast Missouri of remaining habitat for numerous native and threatened plant and animal species. Since the beginning of the 20th century, these lands have been drained and deforested for agricultural purposes, which has highly modified the natural landscapes and ecosystem functions.

Two of the four alternatives, 1 and 2 (Current Management Direction and Expanded Public Use, respectively), would neither reduce nor increase the acreage of bottomland hardwoods at Mingo NWR. The other two alternatives, 3 and 4 (Expanded Habitat Management and Reduce Visitor Conflicts, and Balanced Expanded Public Use and Habitat Management, respectively) would result in a net increase of 1,205 acres of bottomland hardwoods and 547 acres, respectively. Thus, the four alternatives under consideration would either have no long-term, cumulative effects on the area of bottomland hardwoods locally and regionally or have a negligibly beneficial effect on the same.

Environmental Education

Environmental education is provided by a variety of institutions inside and outside of the formal classroom. In addition to K-12 public schools, in which environmental education is generally included under the life and physical sciences, especially biology, but also within chemistry, geography, civics, and history, museums, zoos, parks, libraries, television and the news media (e.g., newspapers, magazines, the Internet) all contribute to improving environmental education for American students and citizens. As a result of the cumulative impact of these combined efforts, in recent decades the average American's level of environmental knowledge and awareness appear to have gradually increased.

At present, Mingo NWR provides a moderate amount of environmental education on and off the Refuge. These efforts are focused primarily on wildlife, habitat, and water management, which is appropriate for a national wildlife refuge. Efforts and results are constrained in part by staffing and budgetary limitations. Under Alternatives 1 and 3, this situation would remain essentially the same, and there would be a continuing moderate contribution to overall environmental education efforts in the

Table 5: Environmental Impacts, Mingo NWR

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Shorebirds	Use of the Refuge would remain stable	Use of the Refuge would remain stable	Use of the Refuge would remain stable or slightly increase	Use of the Refuge would remain stable or slightly increase
Marsh and Wading Birds	Use of the Refuge would remain stable	Use of the Refuge would remain stable or increase	Use of the Refuge would increase	Use of the Refuge would increase
Land Birds	Use of the Refuge would remain stable	Use of the Refuge would increase	Use of the Refuge would increase	Use of the Refuge would increase
Fish and Aquatic Species	Use of the Refuge would remain stable or slightly increase	Use of the Refuge would increase	Use of the Refuge would increase	Use of the Refuge would increase
Reptiles and Amphibians	Use of the Refuge would remain stable or slightly increase	Use of the Refuge would increase	Use of the Refuge would increase	Use of the Refuge would increase
Wildlife Associated with Early Successional Habitats	Amount of permanent openings would remain stable. Amount of temporary forest openings would increase within a portion of the bottomland forest	Amount of permanent openings would remain stable. Amount of temporary forest openings would increase within the entire bottomland forest	All Permanent openings would be converted to bottomland hardwoods. Amount of temporary openings would increase within the entire bottomland forest	Permanent openings would decrease to 531 acres. Amount of temporary openings would increase within the entire bottomland forest.
Cultural Resources	No impacts	No impacts	No impacts	No impacts
Wilderness	No impacts	Increased public awareness and appreciation	Increased public awareness and appreciation. Improved sheet flow.	Increased public awareness and appreciation. Improved sheet flow. Improved wilderness preservation.
Wildlife Disturbance	Potential for disturbance would remain at present level.	Potential for disturbance would increase above present levels.	Potential for disturbance would decrease below present levels.	Potential for disturbance would remain at present levels or slightly increase.
Hunting	Remain stable	Increased opportunities	Remain Stable	Some additional opportunities
Fishing	Remain stable	Increased opportunities.	Decreased opportunities. Eliminate gigging and bow fishing.	Improve facilities. Eliminate gigging and bow fishing.

Table 5: Environmental Impacts, Mingo NWR

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Wildlife Observation & Photography	Remain stable	Increased opportunities	Decreased opportunities. Closed Area to reduce disturbance	Increased opportunities
Environmental Education	Remain stable	Increased opportunities. Friends and others manage EE program on Refuge.	Focus on habitat/ wildlife management themes only.	Increased opportunities that focus on habitat/ wildlife management themes
Interpretation	Remain stable	Increased special events refuge specific programs	Focus on habitat/ wildlife management themes only	Increased opportunities that focus on habitat/ wildlife management themes
Other Compatible Recreation	Remain Stable	Increased opportunities	Decreased Opportunities	Decrease in some activities, increases in others.

region. Under Alternatives 2 and 4, environmental education would receive increasing emphasis both on and off-refuge. These enhanced efforts would likely lead to a concomitant cumulative, beneficial impacts on the level of environmental knowledge and awareness in the citizens of southeastern Missouri.

4.3 Pilot Knob National Wildlife Refuge

4.3.1 Effects Common to Both Alternatives at Pilot Knob NWR

As mentioned above at 4.1.4, neither of the alternatives evaluated for Pilot Knob NWR would have more than negligible or at most minor effects on soils, topography, noise levels, land use patterns in and around the Refuge, transportation and traffic, waste management, human health and safety, or visual resources. In addition, there would minimal to no effects on water resources, terrestrial habitat and biological diversity from either alternative.

4.3.2 Summary of Effects by Alternative for Pilot Knob NWR

Effects are summarized by alternative in Table 6 on page 177.

Alternative 1: Current Management Direction

Alternative 1 would continue the status quo at Pilot Knob National Wildlife Refuge.

With regard to protection of the federally-endangered Indiana bat and its critical habitat – the mine entrance and mine shafts at Pilot Knob – the bat, mine entrance, and mine shafts would all continue to be protected from disturbance or harm, although there would be no law enforcement presence on-site to ensure this. Overall however, in all likelihood, there would be no expected threat to the Indiana bat population hibernating in the abandoned iron mine from implementing Alternative 1.

Under Alternative 1, the Refuge would remain closed to the public at all times. Thus, this alternative would not be responsive to concerns communicated by local stakeholders during scoping that the Refuge be opened to visitors in some fashion. The public has expressed interest in entering the Refuge to enjoy its unique geological features and the 360-degree vista of the surrounding area – including a view of a Civil War battlefield – from the summit of Pilot Knob. This aspiration would remain unfulfilled under the Current Management Direction Alternative.

With respect to Refuge administration and management, under this alternative Pilot Knob would continue to be managed from afar by Mingo NWR staff with only occasional visits to monitor bat hiber-

nation and Refuge structures. Refuge administration would remain off-site, invisible, and unresponsive to local concerns and the surrounding community. This low visibility would continue to contribute to a lack of community support for the Refuge and lack of coordination on local issues between the Service and local stakeholders.

Alternative 2: Expand Species Protection and Opportunities for the Public (Preferred Alternative)

This alternative would strive to both expand the protection of the endangered Indiana and gray bats and at the same time pursue greater opportunities for the public on the Refuge.

With regard to protection of the federally-endangered Indiana bat and its critical habitat – the mine entrance and mine shafts at Pilot Knob – the bat, mine entrance, and mine shafts would all continue to be protected from disturbance or harm under Alternative 2. Law enforcement, now infrequent or sporadic, would be intensified under this alternative, so that while visitation would increase from zero at present to some undetermined figure, it should not become a source of problems for the either bat species or the Indiana bat's critical habitat. Alternative 2 proposes a number of strategies that aim to reduce the incidence of illegal activity within the Refuge. Among them are fence repair and maintenance of boundary signs to help reduce illegal access; developing a cooperative agreement with MDC to share law enforcement on the Refuge; and initiating a Friends group or similar body to act as a sort of "neighborhood watch" that would assist in monitoring activity on the Refuge. In addition, staff would place barriers to restrict access to chasm leading to abandoned mine entrance and explore a seasonal closure to avoid disturbance of hibernating bats. All of these measures should be sufficient to ensure the protection of endangered Indiana and gray bats at Pilot Knob NWR.

Another issue raised in scoping is public use of the Refuge. Under Alternative 2, public visitation at Refuge would be allowed with strict controls to protect Indiana and federally endangered gray bats. A number of strategies would be pursued to encourage public use while protecting critical resources. Among other things, the Service would develop an official Pilot Knob NWR brochure; establish an access road passable by 4-wheel drive vehicle; explore partnership with Fort Davidson State Historic Site to assist with guided tours, and; evaluate the feasibility and compatibility of an observation platform on the summit of Pilot Knob. All of these activities would benefit the public.

With regard to Refuge administration and management, the proposed strategies in Alternative 2 would increase the Service presence at the Refuge and enable the Service to be more engaged with, and supported by, local communities and stakeholders.

4.3.3 Cumulative Impacts Analysis

"Cumulative environmental impacts" refer to those that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In this section, the cumulative impact of each alternative is discussed in terms of the Indiana bat.

Human activities are the main agent of historical population declines in the Indiana bat (MDC, 2004b). Because the Indiana bat migrates between summer and winter ranges, it is faced with different threats specific to each area and habitat. In the winter, human disturbance to hibernating bats has been a main cause of decline. Installation of gates at some cave entrances – designed to protect the bats by preventing human access and disturbance – has also caused population declines by altering temperatures and humidity within the cave, or making the cave inaccessible to the bats. Furthermore, as reservoirs were developed at a number of sites around the country, some caves were permanently lost to flooding.

Historically, deforestation, stream channelization, and agricultural development have threatened Indiana bats and their habitats in their summer range. Indiana bat populations have been in decline since the 1970's (MDC, 2004b). There was an estimated 22 percent decline nationally from the mid-1980s to the mid-1990s and most of this was due to a precipitous 34 percent decline in Missouri (Drobney and Clawson, 1995).

Both the Current Management Direction Alternative (Alternative 1) and Expand Species Protection and Opportunities for the Public Alternative (Alternative 2) would contribute to the recovery of the Indiana bat by protecting this critically important hibernaculum. Alternative 1 would accomplish this in part by prohibiting all public access to the

Table 6: Comparison of Impacts by Management Alternative for Pilot Knob National Wildlife Refuge

Issue	Alternative 1: Current Management Direction	Alternative 2: Expand Species Protection and Opportunities for the Public
Protection of federally-endangered Indiana bat and its critical habitat (mine shafts & entrance)	Indiana bat, mine shaft entrance, and mine would all continue to be protected from disturbance and harm	Indiana bat, mine shaft entrance, and mine would all continue to be protected from disturbance and harm, even allowing for controlled public visitation, through partnerships, enforce-ment, seasonal closures, and education
Public use	Refuge would continue to be closed to all public visitation	Public visitation at Refuge would be allowed with strict controls to protect Indiana and federally endangered gray bats
Refuge administration and management	Refuge administration would remain off-site, invisible, and unresponsive	Service presence at Refuge would become more evident and more engaged with surrounding communities

Refuge. Alternative 2 would promote controlled public access accompanied by a variety of measures to ensure protection of this endangered species.

4.4 Ozark Cavefish National Wildlife Refuge

4.4.1 Effects Common to All Alternatives at Ozark Cavefish NWR

As mentioned above at 4.1.4, neither of the alternatives evaluated for Pilot Knob NWR would have more than negligible or at most minor effects on soils, topography, noise levels, land use patterns in and around the Refuge, transportation and traffic, waste management, human health and safety, or visual resources. In addition, there would minimal to no effects on water resources, terrestrial habitat and biological diversity from either alternative.

4.4.2 Summary of Effects by Alternative for Ozark Cavefish NWR

Predicted effects are summarized by alternative in Table 7 on page 178.

Alternative 1: Current Management Direction

Alternative 1 would continue the status quo at Pilot Knob National Wildlife Refuge.

Protecting the federally listed endangered Ozark Cavefish would remain the top priority of the Refuge. No new steps would be undertaken to accomplish this goal, but nor would actions be pursued that might compromise it. However, as pointed out in scoping, the cavefish faces a small but non-zero risk from possible hazardous material spills along Highway 44 within the recharge area of Turnback Creek. Hypothetically, a spill could contaminate surface water and have adverse effects on the Ozark cavefish and other subterranean species.

Another issue raised in scoping is Refuge management. The Refuge suffers from unenforced regulations and possibly unrealized public use potential. During scoping, a number of comments from the public suggested the Refuge would benefit if it were locally administered and managed.

The Refuge has been administered by the staff at Mingo National Wildlife Refuge, 240 miles away, from the time it was established in 1991. Because of the distant location, the Refuge is visited infrequently and little management or law enforcement activities are carried out on the property. Under this alternative, Ozark Cavefish NWR would continue to be managed from Mingo NWR, visited infrequently, and little managed or enforced.

Public use and visitation would continue to be prohibited under Alternative 1. Local and MDC suggestions to allow for some controlled public use would be ignored.

The Refuge contains a number of federal and state listed rare species, which there are currently no provisions for managing and protecting. Ozark Cavefish NWR has potential to restore the federally threatened Missouri bladder pod. Under the Current Management Direction Alternative however, no such initiatives would be undertaken.

Table 7: Comparison of Impacts by Management Alternative for Ozark Cavefish National Wildlife Refuge

Issue	Alternative 1: Current Management Direction	Alternative 2: Expand Species Protection and Opportunities for the Public
Ozark Cavefish protection	Population of endangered Ozark cavefish likely to survive, but faces some degree of risk from off-Refuge water contamination	Population of endangered Ozark cavefish likely to survive; faces reduced risk from off-Refuge water contamination
Refuge management	Refuge would continue to be managed entirely by Mingo NWR staff from a distance with little or no local input or participation	Refuge management would involve MDC and local stakeholders working in partnership with the Service
Public use	No public use would be permitted	Limited public use would be encouraged; compatible wildlife dependent recreation would be offered at the Turnback Creek portion of the Refuge
Rare species	If populations of other rare species on the Refuge are conserved or recovered, it would not be by design	Cooperation with partners such as MDC and the Neosha National Fish Hatchery may include work for other rare species like the Missouri bladder pod

Alternative 2: Expand Species Protection and Opportunities for the Public

This alternative would strive to expand the protection of the endangered Ozark cavefish and at the same time pursue greater opportunities for the public on the Refuge.

With regard to protecting the Ozark cavefish population itself, Alternative 2 proposes a number of strategies that, if fully implemented, would help safeguard water quality, aquatic habitat, and the endangered fish. These include mapping the recharge area of Hearrell Spring portion of Refuge; working with the Service's Partners for Wildlife program and the MDC's private lands programs to develop a landowner education program; working with MDC, the Missouri Department of Natural Resources, Missouri Department of Transportation, landowners, and others to develop mitigation measures for hazardous materials spills; and monitoring water quality at various locations in the recharge area and communicating water quality trends to landowners. In addition, the Service would post and maintain boundaries and develop a cooperative agreement with MDC to share law enforcement oversight of the Refuge.

With regard to the issue of Refuge management, under this alternative, Pilot Knob would be managed in collaboration with MDC and in consultation with local stakeholders. Several strategies that would help address this issue include: developing a cooperative agreement with MDC to share management oversight of the Refuge; adding a .5 FTE Refuge Operations Specialist (5/7/9) to oversee Refuge management including habitat management, implementing recovery plans, building and maintaining partnerships, and managing visitor services; and developing a cooperative agreement with Missouri Department of Conservation to share law enforcement oversight of the Refuge.

Alternative 2 would encourage Refuge visitor services and public awareness of Ozark Cavefish NWR through a variety of strategies. The Service would maintain a Webcam at Hearrell Spring and provide interpretation. It would also install educational and interpretive kiosks at Hearrell Spring and Turnback Creek portions of Refuge and offering compatible wildlife dependent recreation at the Turnback Creek portion of the Refuge.

Alternative 2 makes no specific provisions for the conservation and restoration of federal and state listed rare species on the Refuge. Nonetheless, the institutional arrangements proposed under this alternative, particularly cooperation with MDC and the Neosho National Fish Hatchery, offer greater prospect for pursuing such actions than do current arrangements.

4.4.3 Cumulative Impacts Analysis

"Cumulative environmental impacts" refer to those that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In this section, the cumulative impact of each alternative is discussed in terms of the endangered Ozark cavefish.

Over-collecting and pollution are thought to be the main factors in the decline of the Ozark cavefish. Low reproductive potential, confined habitat, and the inability to elude prospective captors make the Ozark cavefish vulnerable to over-collection. Cavefish have been used in the pet trade, and there are several documented instances of scientific collectors taking large numbers of Ozark cavefish. A scientific collection in the 193O's from one Arkansas cave may the cause of the present low population there. States have regulations requiring permits for collecting fish species, but from a practical standpoint it is difficult to actually control illegal collecting. Moreover, sinkholes found in the soluble limestone bedrocks in the Ozark cavefish range increase the probability of pollutants entering cave stream systems. For example, development in Greene County, Missouri, resulted in increased problems with groundwater pollution as evidenced by high levels of nickel found in one cave system (USFWS, 1991).

Another factor which may have contributed to the species' current troubled status is the decline of the endangered gray bat. The food supply in a cave is dependent upon an outside energy source. The largest Ozark cavefish populations occur in those caves used by the gray bat, where the bat guano forms the cave's main energy source. A reduction in bat numbers would likely be followed by a decline in the cavefish population (USFWS, 1991).

The Ozark cavefish has been documented in just 21 caves distributed across only seven counties in three states: Benton County, Arkansas; Delaware County, Oklahoma; and Jasper, Lawrence, Greene, and Newton Counties, Missouri. The verified historic range was slightly larger, including at least nine counties and a total of 24 caves. Total population numbers of the Ozark cavefish are unknown and would be impossible to determine because of the inaccessibility of some habitat. Most of the 21 known populations are probably marginal (USFWS, 1991).

At Ozark Cavefish NWR, both Alternative 1 and Alternative 2 would extend protection to the Ozark cavefish, and thus would not be likely to contribute to adverse cumulative impacts on this endangered species. Rather, both alternatives are more likely to contribute to the species' recovery than its continuing demise. However, Alternative 2 proposes a number of measures that would actively pursue protection of this population – such as partnership with MDC, MDNR, and local landowners to protect water quality in the recharge area and prevent hazardous spills. Thus, Alternative 2 is more likely to safeguard the population on the Refuge than Alternative 1, and thereby contribute positively to cumulative effects on the species.

Chapter 5: List of Preparers and Contributors

Refuge Staff:

Kathleen Burchett, Refuge Manager

Phyllis Ford, Administrative Technician

Vergial Harp, Park Ranger

Julia Horrell, Park Ranger

Ray Placher, Maintenance Worker (retired)

Judy Plunkett, Park Ranger

Charles Shaiffer, Biologist (retired)

Doug Siler, Heavy Equipment Operator

Richard Speer, Assistant Refuge Manager

Rudy Williams, Heavy Equipment Operator

Daniel Wood, Biological Technician

Division of Conservation Planning Staff:

Dean Granholm, Refuge Planner

Gabriel DeAlessio, GIS/Biologist

Jane Hodgins, Technical Writer/Editor

Region Office Staff

H. John Dobrovolny, Regional Historic Preservation Officer, Region 3. Historian.

Missouri Department of Conservation

Harriet Weger, Southeast Regional Supervisor

Dave Wissehr, former Duck Creek Conservation Area Manager

Collin Smith, former Duck Creek Conservation Area Manager

Mangi Environmental Group

Leon Kolankiewicz, Biologist/Environmental Planner/Consultant

Others

Leigh Frederickson

Micky Heitmeyer

Chapter 6: Consultation and Coordination With Stakeholders

The Service and Refuge have conducted extensive consultation and coordination over several years with stakeholders in developing the CCP and EA for Mingo, Pilot Knob, and Ozark Cavefish national wildlife refuges. See Chapter 2 of the CCP for a more detailed description of the process.

Three scoping meetings were held for Mingo NWR and one each for Pilot Knob and Ozark Cavefish NWR's. Attendees and participants at these meetings included local citizens and neighbors; recreational users; local, state, and federal government officials and agencies; conservation organizations; and other stakeholders. In the case of Mingo NWR, extended consultation was conducted with the Missouri Department of Conservation.

Chapter 7: References and Literature Cited

Please see Appendix I of the CCP.